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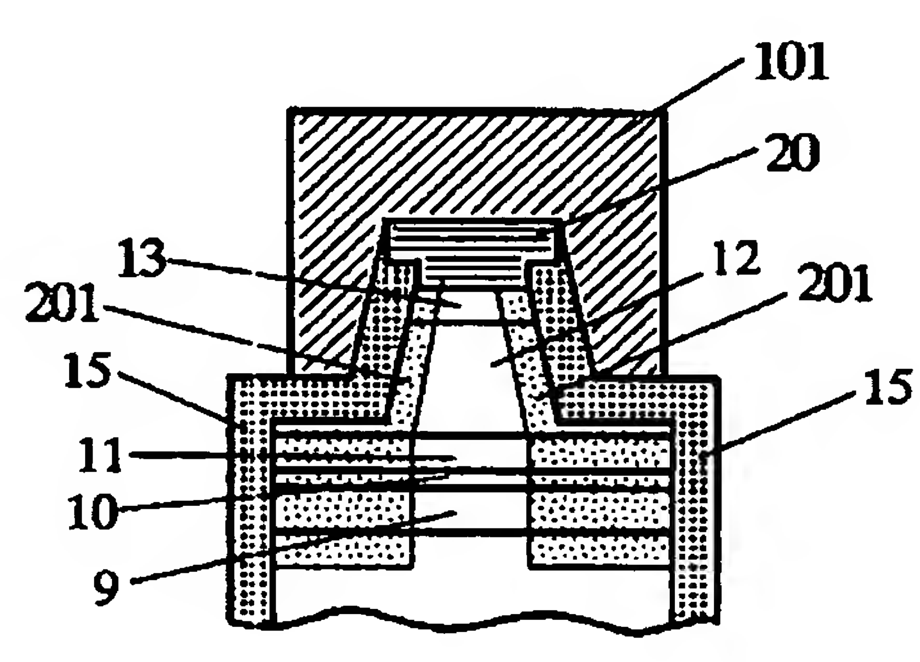
(54)【発明の名称】　窒化物半導体レーザ素子

(57)【要約】
【課題】　素子の絶縁性を良好にして、リーク電流の防止やショートを防止し寿命特性の良好な素子を歩留まりよく得ることができる窒化物半導体レーザ素子を提供することである。
【解決手段】　基板上に、ｎ型窒化物半導体層、活性層及びｐ型窒化物半導体層を成長させてなる素子構造を有し、ｐ型窒化物半導体層側からエッチングによりリッジ形状のストライプが形成されてなり、さらに少なくとも前記リッジ形状のストライプの側面に絶縁膜１５が形成されてなる窒化物半導体レーザ素子で、前記絶縁膜１５と接している少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面付近に、アルミニウム又はホウ素を豊富に含有するリッチ層２０１を有する。



【特許請求の範囲】

【請求項１】　基板上に、少なくともｎ型窒化物半導体層、活性層及びｐ型窒化物半導体層を成長させてなる素子構造を有し、ｐ型窒化物半導体層側からエッチングによりリッジ形状のストライプが形成されてなり、さらに少なくとも前記リッジ形状のストライプの側面に絶縁膜が形成されてなる窒化物半導体レーザ素子において、前記絶縁膜と接している少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面付近に、アルミニウム又はホウ素を豊富に含有するリッチ層を有することを特徴とする窒化物半導体レーザ素子。

【請求項２】　前記リッチ層が、リッジ形状のストライプを形成後、露出されている少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面に、アルミニウム又はホウ素を拡散させることにより形成されてなることを特徴とする請求項１に記載の窒化物半導体レーザ素子。

【請求項３】　前記リッチ層が、リッジ形状のストライプを形成後、露出されている少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面に、アルミニウム又はホウ素をイオン注入して形成されてなることを特徴とする請求項１に記載の窒化物半導体レーザ素子。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は窒化物半導体（$In_aAl_bGa_{1-a-b}N$、０≦a、０≦b、a+b≦１）よりなるレーザ素子に関し、特に絶縁性が良好でリーク電流とショートの防止された寿命の長い窒化物半導体レーザ素子に関する。

【０００２】

【従来の技術】近年、窒化物半導体レーザ素子の実用化のために多くの研究開発が行われており、種々の窒化物半導体レーザ素子が知られている。例えば、本発明者等は、実用可能なレーザ素子として、Jpn.J.Appl.Phys.Vol.37(1998) pp.L309-L312、Part2,No.3B,15 March 1998に、サファイア基板上部に、ＥＬＯＧ（Ｅｐｉｔａｘｉａｌｌｙ　ｌａｔｅｒａｌｌｙ　ｏｖｅｒｇｒｏｗｎ　ＧａＮ）を２０μm形成し、その後ＧａＮを膜厚が１００μmになるまで成長させた後、サファイア基板を削除することで、約８０μmの転位の低減されたＧａＮ基板を得て、このＧａＮ基板上にレーザ素子構造となる窒化物半導体層を複数積層してなる窒化物半導体レーザ素子を発表している。そして、このレーザ素子は、室温での連続発振１万時間以上を可能とする窒化物半導体レーザ素子を発表した。図６に、上記Ｊ．Ｊ．Ａ．Ｐ．に示されるレーザ素子と同様の模式的断面図を示した。この図６に示されるように、ｐ－ＧａＮよりなるｐ型コンタクト層から$p-Al_{0.14}Ga_{0.86}N$／ＧａＮの超格子構造よりなるｐ型クラッド層まで部分的にエッチングして形成されたリッジ形状のストライプを有し、形成されたリッジ形状のストライプの側面には素子の絶縁性のためにSiO_2からなる絶縁膜が形成され、さらに前記ストライプ上部にｐ電極が形成され、劈開により共振面を形成してなる窒化物半導体レーザ素子である。更にこのレーザ素子は、ｐ電極を覆うようにｐパッド電極が形成されている。このようにリッジ形状のストライプの側面に絶縁膜が形成されていることにより、ショートの防止及びリーク電流の防止を行っている。

【０００３】

【発明が解決しようとする課題】しかしながら、得られたレーザ素子の中には、同一条件で形成されたレーザ素子であるにもかかわらず、極端に寿命特性が悪いものが生じる。本発明者は、極端に寿命特性が低下する原因について種々検討した結果、リッジ形状のストライプの側面の絶縁膜の絶縁が不完全なために、リーク電流が生じたり、ショートが発生するためではないかと推測した。レーザ素子を商品化するにあったては、寿命特性等の素子特性を良好にするとと共に、歩留まりの向上を達成することが望まれる。

【０００４】そこで、本発明の目的は、素子の絶縁性を良好にして、リーク電流の防止やショートを防止し寿命特性の良好な素子を歩留まりよく得ることができる窒化物半導体レーザ素子を提供することである。

【０００５】

【課題を解決するための手段】即ち、本発明の目的は、下記（１）～（３）の構成により達成することができる。

（１）　基板上に、少なくともｎ型窒化物半導体層、活性層及びｐ型窒化物半導体層を成長させてなる素子構造を有し、ｐ型窒化物半導体層側からエッチングによりリッジ形状のストライプが形成されてなり、さらに少なくとも前記リッジ形状のストライプの側面に絶縁膜が形成されてなる窒化物半導体レーザ素子において、前記絶縁膜と接している少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面付近に、アルミニウム又はホウ素を豊富に含有するリッチ層を有することを特徴とする窒化物半導体レーザ素子。

（２）　前記リッチ層が、リッジ形状のストライプを形成後、露出されている少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面に、アルミニウム又はホウ素を拡散させることにより形成されてなることを特徴とする前記（１）に記載の窒化物半導体レーザ素子。

（３）　前記リッチ層が、リッジ形状のストライプを形成後、露出されている少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面に、アルミニウム又はホウ素をイオン注入して形成されてなることを特徴とする前記（１）に記載の窒化物

半導体レーザ素子。

【０００６】つまり、本発明は、リッジ形状のストライプの側面等の表面付近に、アルミニウム又はホウ素を豊富に含有させてなるリッチ層を、表面から内部に向かって形成することにより、リッジ形状のストライプの側面に形成される絶縁膜と相乗的に作用して良好な絶縁が可能となり、リーク電流及びショートを良好に防止することが可能となる窒化物半導体レーザ素子を提供することができる。さらに、本発明は、リッチ層を有するレーザ素子とすることで、歩留まりの向上をも達成することができる。

【０００７】従来、リッジ形状のストライプの側面には、図６に示すように絶縁性の絶縁膜が形成されている。しかし、この絶縁膜が均一な良好な膜でない場合が生じてしまい絶縁性が不完全となりショートなどが発生してしまう。

【０００８】これに対して、本発明者は、パッド電極と接する箇所の絶縁性をより一層完全なものにすべく種々検討した結果、アルミニウム（Ａｌ）又はホウ素（Ｂ）をストライプの側面及びストライプの側面から連続している平面の表面付近に豊富に含有させてリッチ層を形成して、リッジ形状のストライプを形成することで露出された素子構造の表面自体を絶縁性にすることにより、リッチ層と絶縁膜とが相乗的に作用して良好な絶縁性を有することができる。

【０００９】さらに、本発明において、リッチ層が、リッジ形状のストライプを形成後、露出されているリッジ形状のストライプの側面などの表面に、アルミニウム又はホウ素を拡散させることにより、又はアルミニウム又はホウ素をイオン注入することにより形成されてなるとリッチ層を良好に形成することができ、より良好な絶縁性を示すと共に歩留まりの向上の点で好ましい。

【００１０】また、本発明において、Ａｌ又はＢを拡散やイオン注入すると、その部分の屈折率が小さくなり光の閉じ込めの点でも好ましい。このことから、例えば図６のレーザ素子は、ｐ電極がｐ型コンタクト層の表面全面に接していないので、実効屈折率導波路型であるが、図６のレーザ素子に、図１に示すように、活性層９の側面までＡｌまたはＢを拡散又はイオン注入して、リッチ層２０１を形成することにより光閉じこめが良好となることで完全屈折率導波路型となり、水平横モードが安定化してしきい値の上昇を防止でき、寿命特性を向上させることができ好ましい。

【００１１】

【発明の実施の形態】以下に図１～図４を用いて本発明をさらに詳細に説明する。図１は、前記従来技術で示した図６のレーザ素子に、本発明のリッチ層２０１を形成してなる一実施の形態である窒化物半導体レーザ素子のリッジ形状のストライプの長さ方向に垂直に切断した一部分を示す模式的断面図である。図２～図４は、完全屈折率導波路型となるレーザ素子に本発明のリッチ層２０１を形成してなる一実施の形態である窒化物半導体レーザ素子の模式的断面図である。

【００１２】本発明の窒化物半導体レーザ素子は、リッジ形状のストライプの側面に絶縁膜が形成されてなる窒化物半導体レーザ素子において、絶縁膜と接している少なくともリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面付近に、アルミニウム又はホウ素を豊富に含有するリッチ層を有する。従って、リッチ層を形成するレーザ素子としては、特に限定されず、リッジ形状のストライプを有するレーザ素子であればよく、例えば具体的には、図１～図４のレーザ素子が挙げられる。

【００１３】まず、図１を用いて、リッチ層２０１について説明する。図１には、リッジ形状のストライプの側面に絶縁膜が形成され、ストライプの最上層にｐ電極２０が形成され、ｐ電極と電気的に接触するようにｐパッド電極がストライプの上方部分に形成されている。そして、素子構造と絶縁膜６２の接しているリッジ形状のストライプの側面及びストライプの側面から連続している平面の表面付近にリッチ層２０１が形成されている。この図１の場合のリッチ層２０１の形成は、従来の素子の形成の工程において、リッジ形状のストライプを形成後に、ｐ型窒化物半導体層の最上面（ｐ型コンタクト層の表面）にリッチ層２０１が形成されないように保護した後で、拡散やイオン注入によりＡｌ又はＢを露出されている表面付近に豊富に含有させる。

【００１４】本発明において、表面付近とは、リッジ形状のストライプを形成した後、露出している素子構造の表面から内側に向かって深さを持っている部分を示す。例えば、図１～４に示されるリッチ層２０１の形成されている部分を示す。また、本発明において、豊富に含有するとは、例えば図２のｐ型コンタクト層及びｐ型クラッド層のように、同一層でありながら他の部分より多くＡｌ又はＢを含有していて、ＡｌやＢが偏在している状態を示す。そして、ＡｌやＢの偏在している部分を本発明ではリッチ層２０１としている。

【００１５】本発明において、リッチ層２０１の形成は、リッジ形状のストライプを形成した後、露出している部分に、特にｐパッド電極が上方部分に形成される箇所の表面付近に、Ａｌ又はＢを豊富に含有させることで形成される。本発明において、ＡｌやＢを豊富に含有させる方法としては、特に限定されないが、例えば好ましい具体例としては、リッチ層を形成したい部分にＡｌやＢを蒸着させた後に熱を加えて拡散させる方法、又はイオン注入による方法などが挙げられる。

【００１６】本発明において、拡散させる方法としては、拡散されたい部分にＡｌ又はＢを蒸着させ、熱処理を行う。熱処理の際の温度としては、適宜調整され、例えば４００℃～７００℃である。熱処理の時間として

は、適宜調整され、例えば１０分～２時間である。また、リッチ層２０１の形成を拡散により行う場合、濃度の調整や、表面からの深さの調節は、熱処理の温度と時間を調整することで行われる。

【００１７】本発明において、イオン注入させる方法としては、注入させたくない部分をＳｉ酸化膜又はレジストなどでマスクし、ウエハ全面にイオン化させたＡｌまたはＢを１０～数百ｋｅＶのエネルギーに加速して表面に打ち込むことで行われる。また、リッチ層２０１の形成をイオン注入により行う場合、濃度の調整や、表面からの深さの調節は、加速電圧を注入時間を調整することで行われる。

【００１８】また、リッチ層２０１のＡｌやＢの濃度としては、特に限定されなが、絶縁性のとれる程度であり、例えば具体的には1×10^{14}ａｔｏｍ／cm^3以上である。また、リッチ層２０１の膜厚（表面からの深さ）は、特に限定されないが、絶縁性のとれる程度であり、例えば具体的には１００オングストローム～２μｍである。

【００１９】例えば、リッジ層２０１の形成の一実施の形態としては、前記従来技術で示したＪ．Ｊ．Ａ．Ｐ．に記載されているように、基板上にｎ型コンタクト層、活性層、ｐ型コンタクト層等を成長させてなる素子構造を形成後、ｐ型窒化物半導体層側からエッチング等によりリッジ形状のストライプを形成後、リッジ形状のストライプの最上層の表面にリッチ層が形成されないようにした状態で（例えばエッチングの際に形成されたレジスト等の保護膜の形成されている状態で）、露出されている少なくともリッジ形状のストライプの側面などに上記に示した拡散やイオン注入によってリッジ層２０１を形成する。その後、前記Ｊ．Ｊ．Ａ．Ｐ．等と同様に絶縁膜１５、ｐ電極２０及びｐパッド電極１０１等を形成する。そして、図１に示されるリッチ層２０１を有するレーザ素子となる。図１の絶縁膜６２としては、特に限定されないが、SiO_2等を用いることができる。また、図１のリッジ形状のストライプとしては、特に限定されないが、例えば前記で示したＪ．Ｊ．Ａ．Ｐ．に記載されている内容と同様の内容が挙げられる。

【００２０】図１に示すレーザ素子は、リッチ層２０１を形成することにより、リッチ層２０１と絶縁膜１５とが相乗的に作用して絶縁性が良好となり、リーク電流の防止及びショートの防止ができ、寿命特性の良好なレーザ素子となる。さらに図１に示すレーザ素子は歩留まりよく作製することができ、量産する際に好ましい。またさらに、本発明のレーザ素子は絶縁性が良好となるので、素子の信頼性の向上（不良防止）の点でも好ましいまた、図１に示されるレーザ素子は、ｐ電極がｐ型コンタクト層の表面全面に接していないので、リッチ層２０１を形成していない状態ではリッジ形状のストライプ内部で電流密度にムラが生じ、水平横モードが不安定となりしきい値の上昇が見られる場合があるが、Ａｌ又はＢを含有させることでその部分の屈折率が小さくなり、光閉じこめが良好となることで、完全屈折率導波路型のレーザ素子のような素子特性を示し易くなる。このように、しきい値の上昇が抑えられれば、寿命特性をより良好にすることができる。図１に示されるリッチ層２０１は、基板に対して水平方向の膜厚と、垂直方向の膜厚が異なるが、リッチ層２０１を形成する際の拡散又はイオン注入の条件により適宜調節することで膜厚を調整できる。ここでリッチ層の膜厚とは、Ａｌ又はＢが素子構造内にどの程度の深さまで入り込んでいるかを示している。

【００２１】次に、図２～図４のレーザ素子について説明する。図２～図４は、ｐ型コンタクト層の表面全面がｐ電極を接していて且つストライプ幅が狭いので、水平横モードが安定化し、しきい値の上昇を抑えられるので好ましく、さらに完全屈折率導波路型のレーザ素子として好ましい構造となる。図２～図５には、基板上に、ｎ型コンタクト層５～ｐ型コンタクト層１３が積層成長され、このｐ型コンタクト層側からエッチングによりリッジ形状のストライプを形成し、リッジ形状のストライプの側面に第２の保護膜６２（本発明の絶縁膜に相当する絶縁性の膜）が形成され、ストライプの最上層であるｐ型コンタクト層に接するようにｐ電極、さらにｐ電極に接するようにｐパッド電極が形成されてなるレーザ素子である。ここで、第２の保護膜６２は、絶縁性の膜であり本発明の絶縁膜に相当し、図１の絶縁膜１５と同様に素子の絶縁性を維持するために形成されるが、図２～図５の形成の段階を説明するに際して第２の保護膜６２とする。そして、このような図２～図５には、各図に示されているように、リッジ形状のストライプの側面及びストライプの側面から連続している平面に、本発明のリッチ層２０１が形成されている。リッチ層２０１が形成されることにより、リッチ層２０１の部分も絶縁性を示し、ストライプの側面に形成されている絶縁性の第２の保護膜６２と相乗的に作用して素子の絶縁性を良好にする。絶縁性が良好となることで、リーク電流の防止及びショートの防止が良好となり、寿命特性の向上及び歩留まりの向上が達成できる。

【００２２】図２～図５に用いられる絶縁膜となる第２の保護膜６２としては、特に限定されないが、例えば、Ｔｉ、Ｖ、Ｚｒ、Ｎｂ、Ｈｆ、Ｔａよりなる群から選択された少なくとも一種の元素を含む酸化物、ＢＮ、ＳｉＣ及びＡｌＮ等が挙げられる。また後述してるように、第２の保護膜６２としてＳｉ酸化物を用いることもでき、この場合は、後述しているように第１の保護膜６１の材料としてＳｉ酸化物よりエッチングされ易い材料を選択して行われる。

【００２３】図２～図５のストライプ構造としては、特に限定されないが、好ましいストライプ構造としては、

例えばストライプ幅が０．５～４．０μmのストライプ構造をあげることができる。ストライプ幅が上記範囲であると、しきい値の低下や水平横モードの安定化の点で好ましい。また、ストライプ幅が上記のように狭い構造のストライプを有するレーザ素子としては、前記したように、例えば図２～図４に示されるような構造のレーザ素子が挙げられる。これらのレーザ素子は、ストライプ幅を狭くしても再現性良く形成することができるストライプ及び電極形成方法（具体的には特開平２０００－４０６３号に開示されている。）により得られる。以下にその方法について図５を用いて説明する。この方法は、ストライプの導波路を形成する際に用いる第１の保護膜６１と、ストライプの側面に形成される絶縁性の第２の保護膜６２との、エッチング処理によるエッチング速度が異なるように材料を選択し、下記各工程を行うことにより、再現性よくストライプを形成でき、更に所定の位置に絶縁性の第２の保護膜６２を均一の膜厚で形成することができる。

【００２４】図５は、図２～図４の窒化物半導体レーザ素子のストライプ及び電極の形成方法の各工程を説明するための、各工程における窒化物半導体ウェーハの部分的な構造を示す模式的断面図である。この図５に示される断面図は、エッチングにより形成したストライプ導波路に対し垂直方向、つまり共振面に対して平行方向で切断した際の図を示している。

【００２５】まず、第１の工程において、図５（ｃ）に示すように、最上層にあるｐ型コンタクト層１３の上にストライプ状の第１の保護膜６１を形成する。この第１の工程において、第１の保護膜６１は、特に絶縁性は問わず、窒化物半導体のエッチング速度と差がある材料であればどのような材料でも良い。更に第１の保護膜６１としては、後述の第３の工程で形成される第２の保護膜６２とエッチング速度の異なる材料を選択して用いることが第２の保護膜６２を形成するのに好ましい。第１の保護膜６１として、例えばＳｉ酸化物（SiO_2を含む）、フォトレジスト等が挙げられ、好ましくはＳｉ酸化物である。第１の保護膜６１が、Ｓｉ酸化物であると、次の第２の工程における窒化物半導体レーザ素子のストライプ状の導波路領域を形成する方法としてウエットエッチングやドライエッチング等が用いられるが、エッチングのし易いドライエッチングが好ましく用いられ、このドライエッチングで重要視される第１の保護膜６１と窒化物半導体との選択性を良好にすることができる。また、第１の保護膜６１が上記の材料から選択されると、後工程である第３の工程で酸を用いて行うエッチングで第２の保護膜よりも酸に対して溶解されやすい性質を有し、第２の保護膜６２との溶解度差を設け易く、特に第３の工程で用いられる酸としてフッ酸を用いると、フッ酸に対して溶解しやすく好ましい。第１の保護膜のストライプ幅（Ｗ）としては４μm～０．５μm、好ましくは３μm～１μmに調整する。第１の保護膜６１のストライプ幅が、おおよそ導波路領域のストライプ幅に相当する。

【００２６】第１の工程において、第１の保護膜６１を形成する具体的な工程として、図５（ａ）、（ｂ）に示す工程が挙げられる。まず、図５（ａ）に示すように、第１の保護膜６１をｐ型コンタクト層１３の表面のほぼ全面に形成した後、第１の保護膜６１の上にストライプ状の第３の保護膜６３を形成する。その後、図５（ｂ）に示すように、その第３の保護膜６３をつけたまま、第１の保護膜６１をエッチングした後、第３の保護膜６３を除去することにより、図５（ｃ）に示すようなストライプ状の第１の保護膜６１を形成することができる。なお第３の保護膜６３をつけたままエッチングガス、若しくはエッチング手段等を変えて、ｐ型コンタクト層１３側からエッチングすることもできる。

【００２７】第１の工程において、エッチング手段としては、例えばＲＩＥ（反応性イオンエッチング）のようなドライエッチングを用いることができ、この場合、第１の工程で例えばＳｉ酸化物よりなる第１の保護膜６１をエッチングするには、CF_4のようなフッ素化合物系のガスを用いることが望ましい。

【００２８】また、図５（ｃ）に示すようなストライプ状の第１の保護膜６１をリフトオフ法によって形成することもできる。リフトオフ法では、ストライプ状の孔が開いた形状のフォトレジストをｐ型コンタクト層１３上に形成し、そのフォトレジストの上から全面に第１の保護膜６１を形成し、その後フォトレジストを溶解除去することにより、ｐ型コンタクト層１３と接触している第１の保護膜６１のみを図５（ｃ）に示すように残すものである。なお、第１の保護膜６１を形成する方法としては、リフトオフ法でストライプ状の第１の保護膜６１を形成するよりも、図５（ａ）、（ｂ）のようにエッチングにより形成する方が端面がほぼ垂直で形状が整ったストライプが得られやすい傾向にある。

【００２９】次に第２の工程において、図５（ｄ）に示すように、第１の保護膜６１が形成されたｐ型コンタクト層１３の第１の保護膜６１が形成されていない部分からエッチングして、第１の保護膜６１の直下部分に保護膜の形状に応じたストライプ状の導波路領域を形成する。エッチングを行う場合、エッチストップをどの位置にするかでレーザ素子の構造、特性が異なってくる。エッチストップはｐ型コンタクト層よりも下の層であればどの窒化物半導体層で止めてもよい。図５に示す例ではｐ型コンタクト層１３の下にあるｐ型クラッド層１２の途中をエッチストップとしている。ｐ型クラッド層の下端面からｐ型コンタクト層方向０．２μmよりも基板側をエッチストップとすると、ストライプがリッジとなって屈折率導波路型のレーザ素子ができる。下端面とは厚さ方向に対して最も下のクラッド層の面を指し、先にも

述べたようにクラッド層の下に光ガイド層がある場合には、ガイド層とクラッド層の界面が下端面に相当する。エッチストップをこの下端面よりも上にすると、エッチング時間が短くなり、またエッチングレートを制御しやすいので、生産技術上都合がよい。

【００３０】また図５には示していないが、エッチストップをｐ型クラッド層の下端面よりも下にある窒化物半導体とすることもできる。下端面よりも基板側の層をエッチストップとすると、しきい値が著しく低下する傾向があり好ましい。

【００３１】第２の工程において、エッチング手段としては、ウエットエッチングやドライエッチング等が用いられるが、エッチングのし易いドライエッチングが好ましく用いられる。例えばＲＩＥ（反応性イオンエッチング）のようなドライエッチングを用いることができ、この場合、窒化物半導体をエッチングするには他のIII－Ｖ族化合物半導体で良く用いられているCl_2、CCl_4、$SiCl_4$のような塩素系のガスが用いられ、これらのガスを用いると、第１の保護膜６１としてＳｉ酸化物が用いられている場合、Ｓｉ酸化物との選択比が大きくできるため望ましい。

【００３２】図5の（ｄ）に示すようにエッチングしてリッジ形状のストライプを形成した後、リッチ層２０１を形成する。リッチ層２０１の形成の方法は前記したとおりである。図５（ｅ－１）には、蒸着によりリッジ形状のストライプの側面及びその側面から連続している平面にＡｌなどの蒸着膜を形成した状態を示してある。このＡｌなどの蒸着膜を形成後、熱拡散によりＡｌなどの蒸着膜と接している素子構造の表面から内部に向かってＡｌなどの豊富な部分を形成する。その後、図５（ｅ－２）に示すようにＡｌなどの蒸着膜を除去することでリッチ層２０１を形成することができる。

【００３３】次にリッチ層２０１を形成した後、第3の工程において、図５（ｆ）に示すように、第２の保護膜６２を第１の保護膜６１と異なる材料であって、絶縁性を有する材料を用いてストライブ状の導波路の側面、エッチングされて露出した窒化物半導体層（図５（ｆ）では、ｐ型クラッド層１２）の平面、及び第１の保護膜６１上に形成する。第２の保護膜６２を形成後に、エッチングにより第１の保護膜６１を除去することにより、第１の保護膜６１上に形成された第２の保護膜６２のみが除去され、図５（ｇ）に示すように、ストライプの側面及びｐ型クラッド層１２の平面には第２の保護膜６２が連続して形成される。このように第２の保護膜６２をエッチングすることなく、第１の保護膜６１を除去することを可能にするには、前記したように、第１の保護膜６１と第２の保護膜６２の材料を、第３の工程で行われるエッチング処理に対するエッチング速度の異なるものを選択して用いることにより可能となる。第３の工程でのエッチング処理は、特に限定されないが、例えばフッ酸を用いてドライエッチングする方法が挙げられる。

【００３４】第２の保護膜６２の材料としては、第１の保護膜６１と異なる材料から選択され、第３の工程のエッチング処理で第１の保護膜６１よりエッチング速度が遅い又はエッチングされにくい材料であって、ストライプの側面等に第２の保護膜６２が形成可能な材料であれば特に限定されない。好ましい第２の保護膜としては、前記のように第１の保護膜６１としてＳｉ酸化物やレジスト材料が好ましく用いられることから、少なくとも第１の保護膜６１の材料以外の材料で、第１の保護膜６１よりエッチング速度が遅い材料が挙げられる。第１の保護膜６１がＳｉ酸化物である場合、第２の保護膜６２の具体例としては、例えばＴｉ、Ｖ、Ｚｒ、Ｎｂ、Ｈｆ、Ｔａよりなる群から選択された少なくとも一種の元素を含む酸化物、ＢＮ、ＳｉＣ及びＡｌＮの内の少なくとも一種が用いられ、より好ましくはＺｒの酸化物、Ｈｆの酸化物、ＢＮ及びＳｉＣのいずれか一種以上の材料が用いられる。また、第２の保護膜６２形成後、窒化物半導体をエッチングしないため、第２の保護膜６２は、窒化物半導体とのエッチング速さに関して考慮されない。また第２の薄膜層６２として、Ｓｉ酸化物を用いてもよく、この場合は、第１の保護膜６１をＳｉ酸化物より第３の工程でのエッチング速度の速い材料が選択され行われる。

【００３５】また、上記の如く、第１の保護膜６１上に第２の保護膜を連続して形成することにより、高い絶縁性を保持でき、ｐ型クラッド層１２の上に均一な膜厚で形成できるため膜厚の不均一に起因する電流の集中の発生を防止できる。また、上記第２の工程において、エッチストップをｐ型クラッド層１２の途中としているため、第３の工程で図５（ｆ）に示すように、第２の保護膜６２はｐ型クラッド層１２の平面に形成されるが、エッチストップをｐ型クラッド層１２よりも下にすると、第２の保護膜はエッチストップした窒化物半導体層の平面に形成される。

【００３６】また、第２の保護膜６２は、リフトオフ法によって形成することもできる。例えば、第２の保護膜６２が上記した具体例のいずれかであり、第１の保護膜６１をＳｉ酸化物とすると、第２の保護膜６２は、フッ酸に対して、Ｓｉ酸化物よりエッチング速度が遅い又はエッチングされにくいといったエッチング選択性を有している。このため、図５（ｆ）に示すようにストライブ導波路の側面、そのストライブが形成されている平面（エッチストップ層）、及び第１の保護膜６１の表面に連続して第２の保護膜を形成した後、リフトオフ法により第１の保護膜６１のみを除去すると、図５（ｇ）に示すような、平面に対して膜厚が均一な第２の保護膜６２が形成される。

【００３７】次に第４の工程において、図５（ｈ）に示すように、第２の保護膜６２とｐ型コンタクト層１３の

上に、そのｐ型コンタクト層１３と電気的に接続したｐ電極２０を形成する。ここで、前記工程により既に第２の保護膜６２が形成されているので、ｐ電極を形成する際、ストライプ幅の狭いコンタクト層のみに形成するといった細かい操作の必要がなく、ｐ電極を大面積で形成でき、操作性が良好となる。

【００３８】また、本発明において、上記のような幅の狭いリッジ形状のストライプを有す得る場合、ｐ電極上に形成されるｐパッド電極としては、特に限定されないが、好ましくは、少なくともストライプ長さと同一の長さでｐ電極全面を覆って形成された金属を含む第１の薄膜層と、該第１の薄膜層上にストライプ長さより短い長さで形成された金属を含む第２の薄膜層とから形成され、または第１と第２の薄膜層との間に第３の薄膜層を形成してなると、ｐパッド電極の劈開性が向上し、ｐ電極の剥離を防止するのに好ましい。例えば、後述の実施例で用いられている図２等に示されている第１の薄膜層３１上に第２の薄膜層３２を形成してなるｐパッド電極１０１が挙げられる。

【００３９】第1の薄膜層が、Ｎｉ、Ｔｉ、Ｃｒ、W及びＰｔ等の一種以上であると、劈開性、接着性、さらに放熱性等の点で好ましい。また、第２の薄膜層が、Ａｕからなると、熱伝導率がよく熱の放散が良好となり、さらにボンディングの際の接着性や衝撃の緩和等の点で好ましい。Ａｕからなる第２の薄膜層は、劈開性が劣るが、ストライプ長さより短い形状であるので、第２の薄膜層の端面が劈開により形成される劈開面に一致しておらず、ｐパッド電極の劈開性に何ら影響を与えない。また、第１の薄膜層と第２の薄膜層との間に、Ｐｔ、Ｗ、ＴｉＮ、Ｃｒ及びＮｉ等の少なくとも１種以上の材料を含む第３の薄膜層を形成すると、第３の薄膜層がバリア層となり第２の薄膜層の金属が拡散するのを防止でき好ましい。このように第２の薄膜層の拡散を防止できると、抵抗の上昇及びしきい値の上昇が抑えられ、それによってレーザ素子内部での熱の発生が防止されて、寿命特性を向上させるのに好ましい。

【００４０】本発明において、ｐ及びｎ電極としては、種々の材料を適宜選択して用いることができ、例えば前記Ｊ．Ｊ．Ａ．Ｐ．に記載されているオーミック接触を有する電極等が挙げられる。

【００４１】また、ｎ電極が基板裏面に形成される場合、基板裏面にベタにｎ電極を形成後裏面からスクライブスすると、ｎ電極に阻まれて窒化物半導体までスクライブが達しない場合があり、この問題点を防止するために、ウエハの基板裏面にパターン形状のｎ電極を形成することによりスクライブし易くなり、劈開性が向上する。パターン形状としては、ウエハを劈開して得られる１チップの形状が得られやすいように、チップの大きさとほぼ同程度の形状、例えば４００μｍ×４００μｍの形状、であることが好ましい。つまりスクライブライン上及び／または劈開面上にｎ電極が存在しないようにパターンをつけてｎ電極を形成する。更にメタライズ電極もｎ電極と同様のパターン形状でｎ電極上に形成されると、スクライブし易くなり劈開性が向上する。ｎ電極としては、特に限定されないが、例えばＴｉ－Ａｌ、Ｗ－Ａｌ－Ｗ－Ａｕなどを用いることができる。メタライズ電極としてはＴｉ－Ｐｔ－Ａｕ－（Ａｕ／Ｓｎ）［膜厚０．１μｍ－０．２μｍ－０．７μｍ－０．３μｍ］、Ｔｉ－Ｐｔ－Ａｕ－（Ａｕ／Ｓｉ）［膜厚前記と同様］、Ｔｉ－Ｐｔ－Ａｕ－（Ａｕ／Ｇｅ）［膜厚前記と同様］、Ｔｉ－Ｐｔ－Ａｕ－Ｉｎ［膜厚前記と同様］、Ａｕ／Ｓｎ［膜厚０．３μｍ］、Ｉｎ［膜厚前記と同様］、Ａｕ／Ｓｉ［膜厚前記と同様］、Ａｕ／Ｇｅ［膜厚前記と同様］等を用いることができる。ｎ電極が裏面にパターン形状に形成される場合のチップ化の方法としては、例えば、裏面のｎ電極パターン間を裏面からスクライブによりバー状サンプルを作製し、端面へ反射ミラー形成後裏面からスクライブによりチップ化を行うことができる。

【００４２】また本発明のレーザ素子のその他の素子構造としては、特に限定されず、公知の種々の素子構造を用いることができる。本発明のレーザ素子の素子構造を成長させる基板としては、従来知られている、サファイア、スピネル等の異種基板、又は、異種基板の上にＳｉO_2等の窒化物半導体が成長しないかまたは成長しにくい材料からなる保護膜を形成して、その上に選択的に横方向の成長（ラテラル成長）をさせて得られる窒化物半導体基板等が挙げられる。好ましくはラテラル成長させて得られる結晶欠陥の少ない窒化物半導体基板が好ましい。結晶欠陥の少ない窒化物半導体基板上に、素子構造を形成すると、素子を構成する窒化物半導体も結晶欠陥が少なくなり、素子内での発熱を抑えるのに好ましい。また、基板が窒化物半導体基板であると、劈開し易くなりｐ電極の剥がれ防止の点でも好ましい。ラテラル成長に用いられる保護膜は、前記ストライプを形成する際に用いた保護膜とは異なる作用を示す。

【００４３】ラテラル成長を用いて得られる結晶欠陥の少ない窒化物半導体基板の成長方法としては、特に限定されずいずれの方法でもよいが、例えば、J.J.A.P.Vol.37(1998)pp.L309–L312に記載の方法や、本出願人が先に出願した特開平１１－１９１６５９号に開示されている窒化物半導体と異なる異種基板上に成長させた窒化物半導体表面に凹凸部を形成し、その凸部及び凹部の平面上にＳｉO_2等の前記保護膜を形成した後、側面に露出した窒化物半導体より横方向の成長を行い、保護膜上部に互いに横方向に成長した窒化物半導体を繋げる方法等が挙げられる。また、ラテラル成長により得られる窒化物半導体基板は、素子構造を成長させる際に、異種基板を有する状態で行っても、異種基板を除去した状態で行ってもよい。

【００４４】本発明のレーザ素子の共振面は、リッジ形状のストライプと垂直になるように、窒化物半導体の｛１１－００｝面［Ｍ面：六角柱状の結晶の側面に相当する面］で劈開することにより、鏡面状の良好な共振面を形成することができる。窒化物半導体のＭ面での劈開については、例えば本出願人が先に出願した特開平９－２３２６７６号公報に詳細が記載されている。

【００４５】

【実施例】以下の本発明の一実施の形態である窒化物半導体レーザ素子の実施例を示す。しかし本発明はこれに限定されない。

［実施例１］図２は、本発明の一実施例に係るレーザ素子の構造を示す模式的な断面図であり、ストライプ導波路に垂直な方向で切断した際の図を示すものである。以下、この図を基に実施例１について説明する。

【００４６】（下地層２）１インチφ、Ｃ面を主面とするサファイアよりなる異種基板１をＭＯＶＰＥ反応容器内にセットし、温度を５００℃にして、トリメチルガリウム（ＴＭＧ）、アンモニア（NH_3）を用い、ＧａＮよりなるバッファ層を２００オングストロームの膜厚で成長させる。バッファ層成長後、温度を１０５０℃にして、同じくＧａＮよりなる下地層２を４μｍの膜厚で成長させる。この下地層は保護膜を部分的に表面に形成して、次に窒化物半導体基板の選択成長を行うための下地層として作用する。

【００４７】（保護膜３）下地層成長後、ウェーハを反応容器から取り出し、この下地層の表面に、ストライプ状のフォトマスクを形成し、ＰＶＤ装置によりストライプ幅１０μｍ、ストライプ間隔（窓部）２μｍのSiO_2よりなる保護膜３を形成する。

【００４８】（窒化物半導体基板４）保護膜形成後、ウェーハを再度ＭＯＶＰＥの反応容器内にセットし、温度を１０５０℃にして、ＴＭＧ、アンモニアを用い、アンドープＧａＮよりなる窒化物半導体基板４を２０μｍの膜厚で成長させる。この窒化物半導体基板は保護膜３上部において横方向に成長されたものであるため、結晶欠陥が10^5個／cm²以下と下地層２に比較して２桁以上少なくなる。

【００４９】（ｎ型コンタクト層５）次に、アンモニアとＴＭＧ、不純物ガスとしてシランガスを用い、窒化物半導体基板１の上に、１０５０℃でＳｉを3×10^{18}／cm³ドープしたＧａＮよりなるｎ型コンタクト層５を４μｍの膜厚で成長させる。

【００５０】（クラック防止層６）次に、ＴＭＧ、ＴＭＩ（トリメチルインジウム）、アンモニアを用い、温度を８００℃にして$In_{0.06}Ga_{0.94}N$よりなるクラック防止層６を０．１５μｍの膜厚で成長させる。なお、このクラック防止層は省略可能である。

【００５１】（ｎ型クラッド層７）続いて、１０５０℃でＴＭＡ（トリメチルアルミニウム）、ＴＭＧ、アンモニアを用い、アンドープ$Al_{0.16}Ga_{0.84}N$よりなる層を２５オングストロームの膜厚で成長させ、続いてＴＭＡを止めて、シランガスを流し、Ｓｉを1×10^{19}／cm³ドープしたｎ型ＧａＮよりなる層を２５オングストロームの膜厚で成長させる。それらの層を交互積層して超格子層を構成し、総膜厚１．２μｍの超格子よりなるｎ型クラッド層７を成長させる。

【００５２】（ｎ型光ガイド層８）続いて、シランガスを止め、１０５０℃でアンドープＧａＮよりなるｎ型光ガイド層８を０．１μｍの膜厚で成長させる。このｎ型光ガイド層８にｎ型不純物をドープしても良い。

【００５３】（活性層９）次に、温度を８００℃にして、Ｓｉドープ$In_{0.05}Ga_{0.95}N$よりなる障壁層を１００オングストロームの膜厚で成長させ、続いて同一温度で、アンドープ$In_{0.2}Ga_{0.8}N$よりなる井戸層を４０オングストロームの膜厚で成長させる。障壁層と井戸層とを２回交互に積層し、最後に障壁層で終わり、総膜厚３８０オングストロームの多重量子井戸構造（ＭＱＷ）の活性層を成長させる。

【００５４】（ｐ型キャップ層１０）次に、温度を１０５０℃に上げ、ＴＭＧ、ＴＭＡ、アンモニア、Cp_2Mg（シクロペンタジエニルマグネシウム）を用い、ｐ型光ガイド層１１よりもバンドギャップエネルギーが大きい、Ｍｇを1×10^{20}／cm³ドープしたｐ型$Al_{0.3}Ga_{0.7}N$よりなるｐ型キャップ層７を３００オングストロームの膜厚で成長させる。

【００５５】（ｐ型光ガイド層１１）続いてCp_2Mg、ＴＭＡを止め、１０５０℃で、バンドギャップエネルギーがｐ型キャップ層１０よりも小さい、アンドープＧａＮよりなるｐ型光ガイド層１１を０．１μｍの膜厚で成長させる。

【００５６】（ｐ型クラッド層１２）続いて、１０５０℃でアンドープ$Al_{0.16}Ga_{0.84}N$よりなる層を２５オングストロームの膜厚で成長させ、続いてCp_2Mg、ＴＭＡを止め、アンドープＧａＮよりなる層を２５オングストロームの膜厚で成長させ、総膜厚０．６μｍの超格子層よりなるｐ型クラッド層１２を成長させる。

【００５７】（ｐ型コンタクト層１３）最後に、１０５０℃で、ｐ型クラッド層９の上に、Ｍｇを1×10^{20}／cm³ドープしたｐ型ＧａＮよりなるｐ型コンタクト層１３を１５０オングストロームの膜厚で成長させる。

【００５８】以上のようにして窒化物半導体を成長させたウェーハを反応容器から取り出し、最上層のｐ型コンタクト層の表面にSiO_2よりなる保護膜を形成して、ＲＩＥ（反応性イオンエッチング）を用い$SiCl_4$ガスによりエッチングし、図２に示すように、ｎ電極を形成すべきｎ型コンタクト層５の表面を露出させる。このように窒化物半導体を深くエッチングするには保護膜としてSiO_2が最適である。

【００５９】次に、図５（ａ）に示すように、最上層の

ｐ型コンタクト層１３のほぼ全面に、ＰＶＤ装置により、Ｓｉ酸化物（主として、SiO_2）よりなる第１の保護膜６１を０．５μｍの膜厚で形成した後、第１の保護膜６１の上に所定の形状のマスクをかけ、フォトレジストよりなる第３の保護膜６３を、ストライプ幅２μｍ、厚さ１μｍで形成する。

【００６０】次に、図５（ｂ）に示すように第３の保護膜６３形成後、ＲＩＥ（反応性イオンエッチング）装置により、CF_4ガスを用い、第３の保護膜６３をマスクとして、前記第１の保護膜６１をエッチングして、ストライプ状とする。その後エッチング液で処理してフォトレジストのみを除去することにより、図５（ｃ）に示すようにｐ型コンタクト層１３の上にストライプ幅２μｍの第１の保護膜６１が形成できる。

【００６１】さらに、図５（ｄ）に示すように、ストライプ状の第１の保護膜６１形成後、再度ＲＩＥにより$SiCl_4$ガスを用いて、ｐ型コンタクト層１３、およびｐ型クラッド層１２をエッチングして、ストライプ状の導波路領域（この場合、リッジストライプ）を形成する。ストライプを形成する際、そのストライプの断面形状を図２に示すような順メサの形状とすると、横モードがシングルモードとなりやすく非常に好ましい。

【００６２】リッジ形状のストライプを形成後に、ｐ型コンタクト層１３にリッチ層が形成されないように保護するための膜を付けた状態で、リッジ形状のストライプの側面及びその側面から連続している平面上にＡｌをＰＶＤ装置により蒸着して蒸着膜を形成する［図５（ｅ－１）］。次にアニール炉において、所定の時間、熱をかけて熱処理を行う。その後、酸でＡｌの蒸着膜を除去する。このようにして図５（ｅ－２）のようにリッチ層２０１が形成される。

【００６３】リッチ層２０１を形成後、ウェーハをＰＶＤ装置に移送し、図５（ｆ）に示すように、Ｚｒ酸化物（主としてZrO_2）よりなる第２の保護膜６２を、第１の保護膜６１の上と、エッチングにより露出されたｐ型クラッド層１２の上に０．５μｍの膜厚で連続して形成する。

【００６４】次に、ウェーハをフッ酸に浸漬し、図５（ｇ）に示すように、第１の保護膜６１をリフトオフ法により除去する。

【００６５】次に図５（ｈ）に示すように、ｐ型コンタクト層１３の上の第１の保護膜６１が除去されて露出したそのｐ型コンタクト層の表面にＮｉ／Ａｕよりなるｐ電極２０を形成する。但しｐ電極２０は１００μｍのストライプ幅として、この図５（ｈ）に示すように、第２の保護膜６２の上に渡って形成する。

【００６６】次に、ｐ電極２０上の全面に連続して、Ｔｉからなる第１の薄膜層３１を１０００オングストロームの膜厚で形成し、更に図２に示すようにストライプの側面等にも第１の薄膜層３１を形成する。この連続して形成された第１の薄膜層３１上に、後の工程で劈開により共振面を形成する際の劈開面に一致しない大きさ、つまり劈開面となる部分の上部を避けて、断続的にＡｕからなる第２の薄膜層３２を８０００オングストロームの膜厚で形成し、第１の薄膜層３１及び第２の薄膜層３２からなるｐパッド電極１０１を形成する。

【００６７】ｐパッド電極形成後、一番最初に露出させたｎ型コンタクト層５の表面にはＴｉ／Ａｌよりなるｎ電極２１をストライプと平行な方向で形成し、その上にＴｉ／Ｐｔ／Ａｕよりなるｎパッド電極を形成する。

【００６８】以上のようにして、ｎ電極とｐ電極及びｐパッド電極とを形成したウェーハのサファイア基板を研磨して７０μｍとした後、ストライプ状の電極に垂直な方向で、基板側からバー状に劈開し、劈開面（１１－００面、六角柱状の結晶の側面に相当する面＝Ｍ面）に共振器を作製する。共振器面にSiO_2とTiO_2よりなる誘電体多層膜を形成し、最後にｐ電極に平行な方向で、バーを切断して図２に示すようなレーザ素子とする。なお共振器長は３００～５００μｍとすることが望ましい。

【００６９】このレーザ素子をヒートシンクに設置し、それぞれの電極をワイヤーボンディングして、室温でレーザ発振を試みたところ、発振波長４００～４２０ｎｍ、閾値電流密度２．９ｋＡ／cm^2において室温で良好な連続発振を示す。さらに、絶縁性が良好となったことで、リーク電流やショートが防止でき、寿命特性の良好なレーザ素子を効率よく得ることができ、歩留まりが向上する。

【００７０】［実施例２］実施例１において、Ａｌからなるリッチ層２０１をイオン注入により形成する他は同様にしてレーザ素子を作製する。イオン注入の方法としては、ｐ型コンタクト層１３の最上面に保護膜を付けた状態で、イオン注入装置でウエハ上面よりＡｌを所定のエネルギーに加速してウエハに打ち込む。次に、イオン注入でダメージを受けた部分を熱処理をして再結晶化させる。得られたレーザ素子は、実施例１と同様に良好な素子特性を示し、さらに歩留まりも向上する。

【００７１】［実施例３］図３は本発明の他の実施例に係るレーザ素子の構造を示す模式的な断面図であり、以下この図を元に実施例３について説明する。

【００７２】（窒化物半導体基板４０）実施例１において、下地層２の表面にストライプ状の保護膜３形成後、ウェーハを再度ＭＯＶＰＥの反応容器内にセットし、温度を１０５０℃にして、ＴＭＧ、アンモニアを用い、アンドープＧａＮを５μｍの膜厚で成長させる。その後、ウェーハをＨＶＰＥ（ハイドライド気相成長法）装置に移送し、原料にＧａメタル、ＨＣｌガス、及びアンモニアを用い、アンドープＧａＮよりなる窒化物半導体基板４０を２００μｍの膜厚で成長させる。このようにＭＯＶＰＥ法により保護膜３の上に窒化物半導体を成長させ

た後、ＨＶＰＥ法で１００μm以上のＧａＮ厚膜を成長させると結晶欠陥は実施例１に比較してもう一桁以上少なくなる。窒化物半導体基板４０成長後、ウェーハを反応容器から取り出し、サファイア基板１、バッファ層２、保護膜３、アンドープＧａＮ層を研磨により除去し、窒化物半導体基板４０単独とする。

【００７３】後は実施例１と同様にして、研磨側と反対側の窒化物半導体基板４０の上にｎ型コンタクト層５～ｐ型コンタクト層１３までを積層する。

【００７４】ｐ型コンタクト層１３成長後、実施例１と同様にして、ストライプ状の第１の保護膜６１を形成した後、第２の工程において、エッチングストップをｎ型コンタクト層５の表面とする。後は実施例１と同様にして、Ａｌからなるリッチ層２０１を形成した後で、ZrO_2を主成分とする第２の保護膜６２をストライプ導波路の側面、及びｎ型コンタクト層５の表面に形成した後、それぞれのコンタクト層に電極を形成する。次に、実施例１と同様にｐパッド電極１０１を形成し、図３に示すような構造のレーザ素子とする。なお共振面を形成する場合、窒化物半導体基板の劈開面は実施例１と同じM面とする。得られたレーザ素子は実施例１に比較して、閾値電流密度は１．８ｋＡ／cm²にまで低下し、寿命は３倍以上向上し、さらに実施例１と同様に絶縁性の向上によりリーク電流及びショートが良好に防止でき、良好な寿命特性を有するレーザ素子を歩留まりよく作製することができる。

【００７５】［実施例４］図４は本発明の他の実施例に係るレーザ素子の構造を示す模式的な断面図であり、以下この図４を用いて実施例４について説明する。

【００７６】実施例３において、窒化物半導体基板４０を作製する際にＨＶＰＥ装置において原料にシランガスを加え、Ｓｉを1×10^{18}／cm³ドープしたＧａＮよりなる窒化物半導体基板５０を２００μmの膜厚で成長させる。なおＳｉ濃度は1×10^{17}／cm³～5×10^{19}／cm³の範囲とすることが望ましい。窒化物半導体基板５０成長後、実施例３と同様にしてサファイア基板１、バッファ層２、保護膜３、アンドープＧａＮ層を研磨して除去し、窒化物半導体基板５０単体とする。

【００７７】次にこの窒化物半導体基板５０の上に実施例１と同様にして、クラック防止層６～ｐ型コンタクト層１３までを積層成長させる。ｐ型コンタクト層１３成長後、実施例１と同様にして、ストライプ状の第１の保護膜６１を形成した後、第２の工程において、エッチングストップを図５に示すｎ型クラッド層７の表面とする。後は実施例１と同様にして、リッチ層２０１を形成し、その後、ZrO_2を主成分とする第２の保護膜６２をストライプ導波路の側面と、ｎ型クラッド層７の表面とに形成した後、その第２の保護膜を介してｐ電極２０を形成する。

【００７８】次に、ｐ電極２１上に、ストライプ長さと同一の長さとなるようにＴｉからなる第１の薄膜層３１を膜厚１０００オングストロームで、第２の薄膜層３２の形状と同様の形状でＰｔよりなる第３の薄膜層を膜厚１０００オングストロームで、及びストライプ長さより短い形状でＡｕからなる第２の薄膜層３２を膜厚８０００オングストロームで順に積層形成してなるｐパッド電極１０１を図４に示すように形成する。第３の薄膜層は図示していないが、第２の薄膜層と同様の形状で形成する。一方、窒化物半導体基板の裏面側のほぼ全面にｎ電極２１を形成する。電極形成後、窒化物半導体基板のM面で劈開して共振面を作製し、図４に示すような構造のレーザ素子とする。

【００７９】［実施例５］前記Ｊ．Ｊ．Ａ．Ｐ．に記載されているレーザ素子を示す図６のレーザ素子に、図１に示すように、実施例１と同様にしてリッチ層２０１を形成してなるレーザ素子を作製する。得られたレーザ素子は、絶縁性が良好となりリーク電流の発生やショートの発生を防止でき、寿命特性の良好な素子を歩留まりよく作製することができる。

【００８０】［実施例６］実施例１において、Ａｌに替えてＢを用いる他は同様にして、拡散によりＢを豊富に含有するリッチ層２０１を形成されてなるレーザ素子を作製する。その結果、実施例１とほぼ同等の良好な結果が得られる。

【００８１】［実施例７］実施例２において、Ａｌに替えてＢを用いる他は同様にして、イオン注入によりＢを豊富に含有するリッチ層２０１を形成されてなるレーザ素子を作製する。その結果、実施例１とほぼ同等の良好な結果が得られる。

【００８２】

【発明の効果】本発明の窒化物半導体レーザ素子は、上記のように素子構造のリッチ形状のストライプの側面及びその側面から連続している平面の表面付近にＡｌ又はＢを豊富に含有するリッチ層を形成することにより、絶縁膜（第２の保護膜を含む）とリッチ層とが相乗的に作用して良好な絶縁性を有するレーザ素子を作製することができる。そして、リーク電流の防止やショートを防止が防止でき寿命特性の良好なレーザ素子を歩留まりよく得ることができる。またさらに、本発明は、リッチ層の形成の状態により、光閉じこめを良好にすることができ、実効屈折率型の素子構造であっても、完全屈折率型の素子構造に変更することが可能となり、水平横モードの安定化やしきい値の低下の点で好ましいレーザ素子となる。

【図面の簡単な説明】

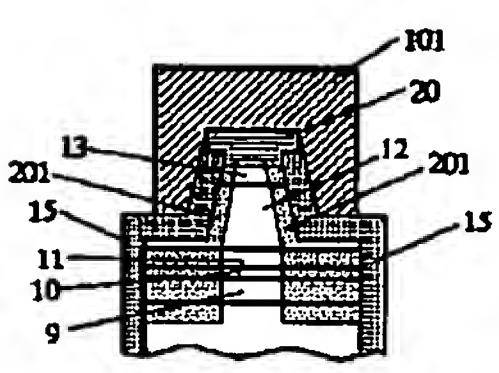
【図１】本発明の一実施の形態に係る窒化物半導体レーザ素子の一部分を示す模式的断面図である。

【図２】本発明の一実施の形態に係る窒化物半導体レーザ素子の模式的断面図である。

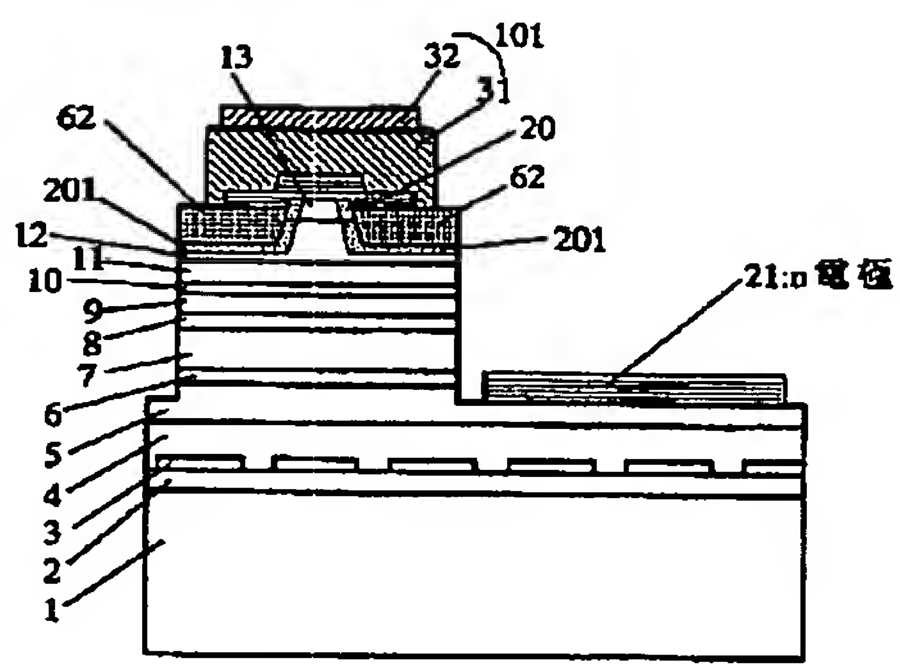
【図３】本発明の一実施の形態に係る窒化物半導体レー

ザ素子の模式的断面図である。
【図４】本発明の一実施の形態に係る窒化物半導体レーザ素子の模式的断面図である。
【図５】図２～図４のリッジ形状のストライプなどを形成する方法の各工程を説明するための、各工程におけるウェーハの部分的な構造を示す模式的断面図である。
【図６】従来のレーザ素子の構造を示す模式的断面図である。
【符号の説明】
１・・・異種基板
２・・・下地層
３・・・窒化物半導体基板成長用の保護膜
４、４０、５０・・・窒化物半導体基板
５・・・ｎ型コンタクト層
６・・・クラック防止層
７・・・ｎ型クラッド層
８・・・ｎ型光ガイド層
９・・・活性層
１０・・・ｐ型キャップ層
１１・・・ｐ型光ガイド層
１２・・・ｐ型クラッド層
１３・・・ｐ型コンタクト層
１５・・・絶縁膜
６１・・・第１の保護膜
６２・・・第２の保護膜
６３・・・第３の保護膜
２０・・・ｐ電極
２１・・・ｎ電極
３１・・・第１の薄膜層
３２・・・第２の薄膜層
１０１・・・パッド電極
２０１・・・リッチ層

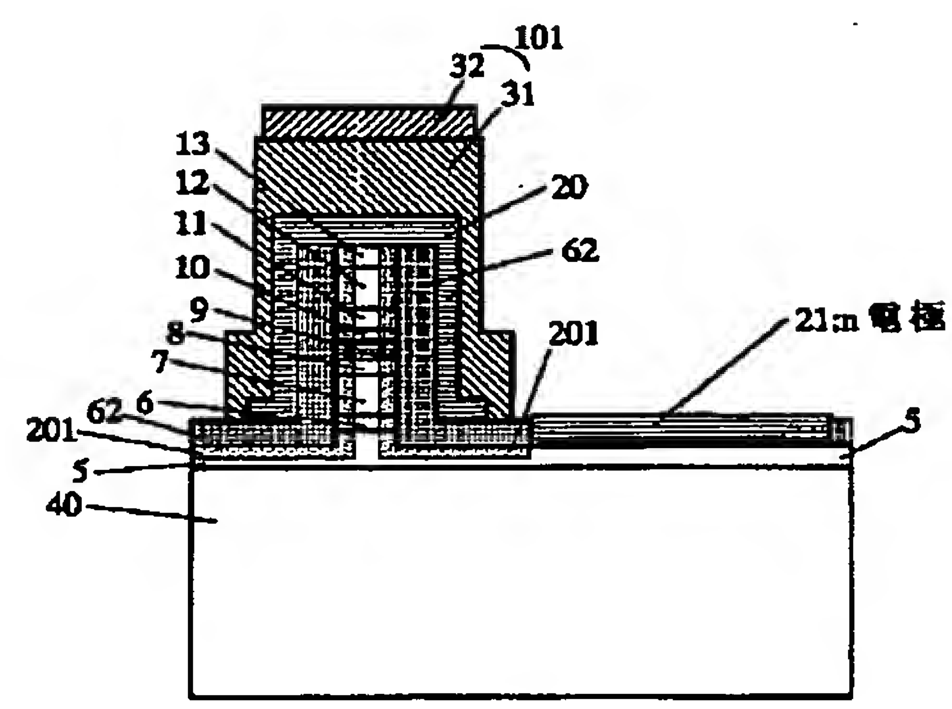
【図１】



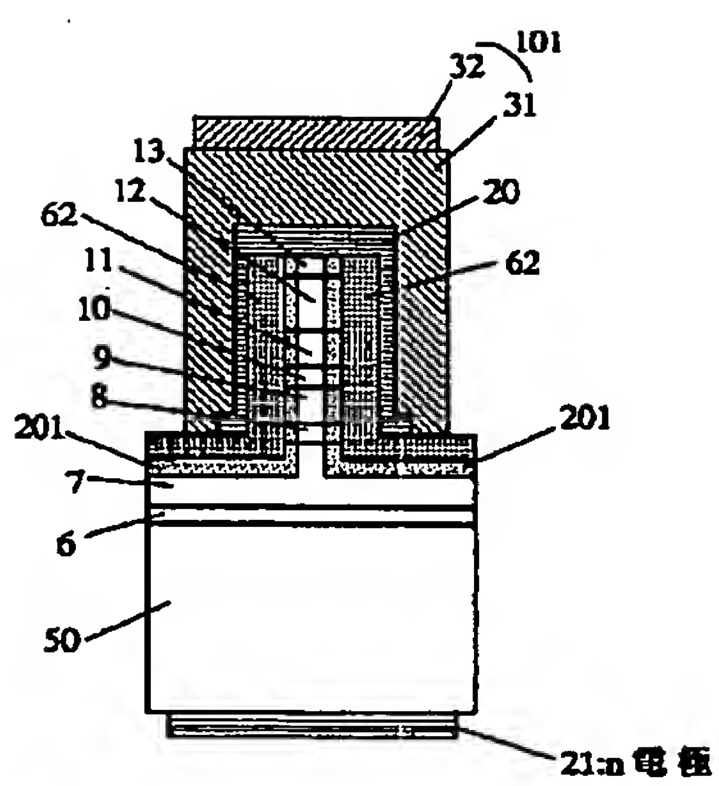
【図２】



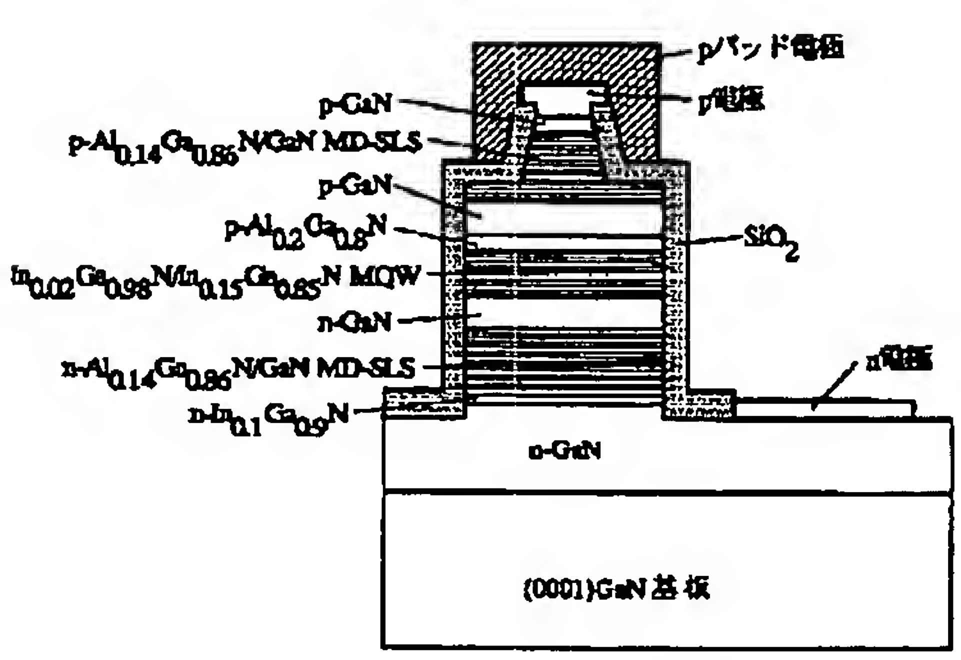
【図３】



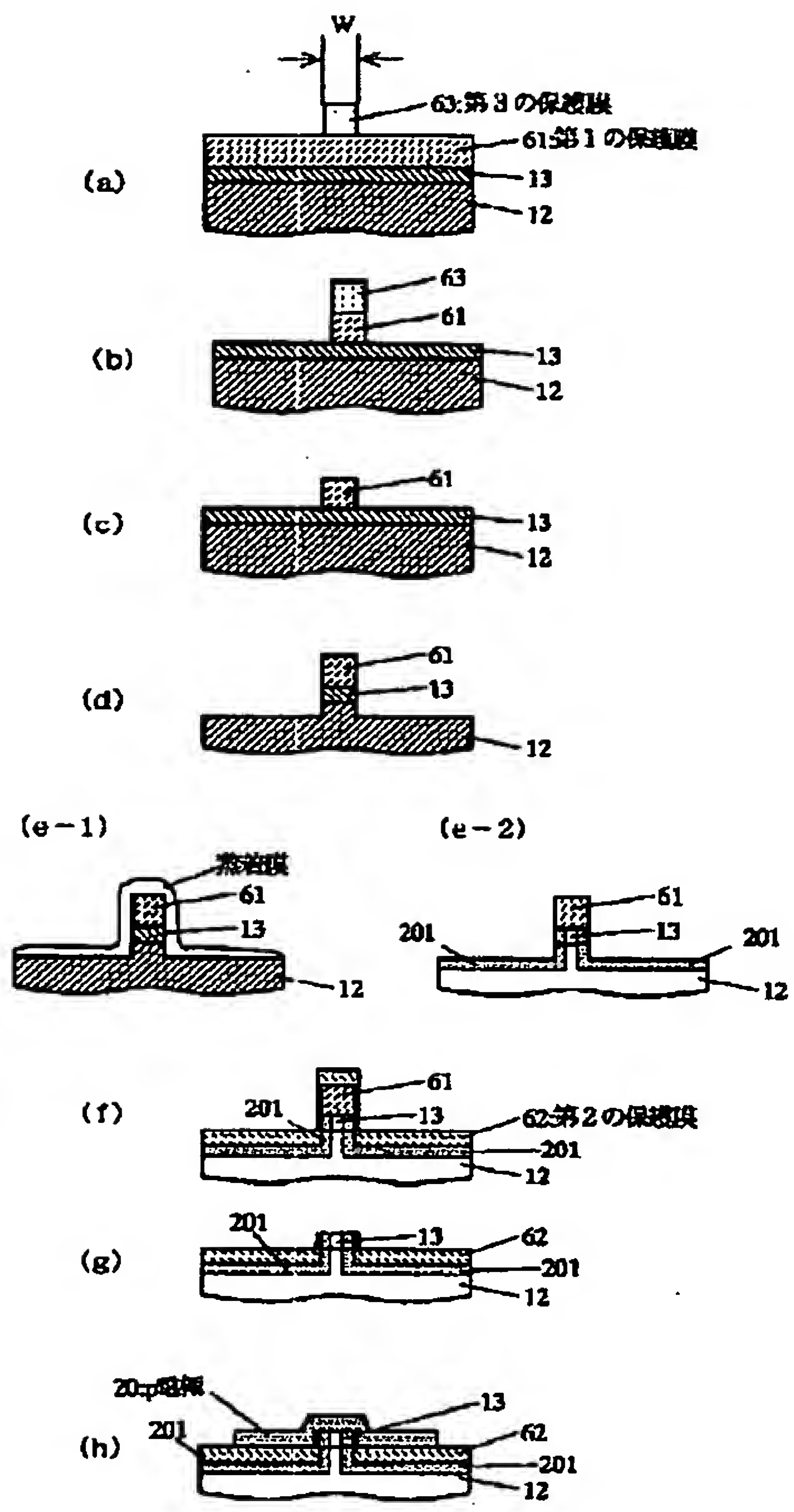
【図４】



【図６】



【図５】



フロントページの続き

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HA15 HA16
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CB05 DA13 DA14 DA16 DA32
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PATENT ABSTRACTS OF JAPAN

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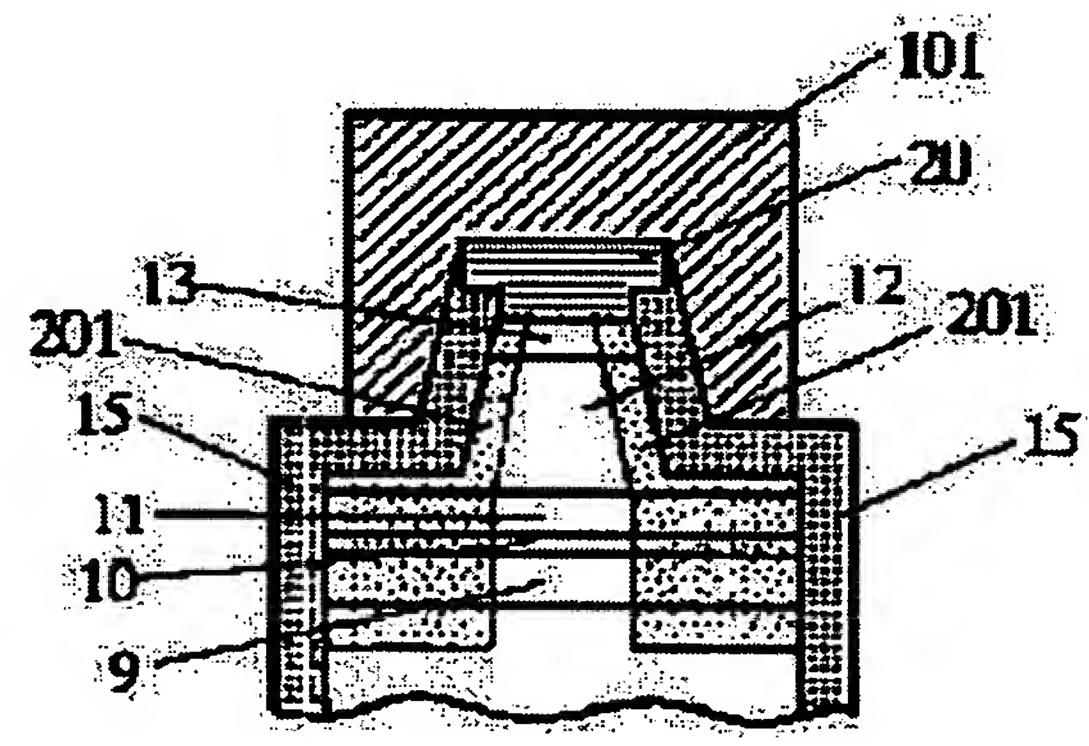
(21)Application number :	2000-023297	(71)Applicant :	NICHIA CHEM IND LTD
(22)Date of filing :	27.01.2000	(72)Inventor :	MATSUMURA HIROAKI

(54) NITRIDE SEMICONDUCTOR LASER ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a nitride semiconductor laser element, where the insulating property of the element is improved, leakage current and short-circuitting are prevented and elements superior in service life characteristic can be obtained with high yield.
SOLUTION: This nitride semiconductor laser element has a structure, where an N-type nitride semiconductor layer, an active layer and a P-type nitride semiconductor layer are grown on a substrate. A ridge-shaped stripe is formed from the P-type nitride semiconductor layer side through etching, and an insulating film 15 is formed at least on the side surface of the ridge-shaped stripe. A rich layer 201, containing abundant aluminum or boron is formed at least on a side surface of the ridge-shaped stripe which is in contact with the insulation film 15 and in the vicinity of a plane surface which continues from the side surface of the stripe.



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registration]

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CLAIMS

[Claim(s)]
[Claim 1] It has the component structure of making n mold nitride semi-conductor layer, a barrier layer, and p mold nitride semi-conductor layer coming to grow up at least on a substrate. In the nitride semiconductor laser component which etching comes to form the stripe of a ridge configuration from p mold nitride semi-conductor layer side, and comes to form an insulator layer in the side face of the stripe of said ridge configuration further at least The nitride semiconductor laser component characterized by having the rich layer which contains aluminum or boron at abundance near the front face of the flat surface which is in contact with said insulator layer, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least.
[Claim 2] The nitride semiconductor laser component according to claim 1 characterized by coming to form said rich layer in the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least by diffusing aluminum or boron after forming the stripe of a ridge configuration.
[Claim 3] The nitride semiconductor laser component according to claim 1 characterized by said rich layer carrying out the ion implantation of aluminum or the boron to the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least, and coming to form it in it after forming the stripe of a ridge configuration.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Especially insulation of this invention is good about the laser component which consists of a nitride semi-conductor (InaAlbGa1-a-bN, 0<=a, 0<=b, a+b<=1), and it is related with the long nitride semiconductor laser component of the life from which leakage current and a short circuit were prevented.
[0002]
[Description of the Prior Art] In recent years, many researches and developments are done for utilization of a nitride semiconductor laser component, and various nitride semiconductor laser components are known. this invention person etc. as a usable laser component for example, to Jpn.J.Appl.Phys.Vol.37(1998) pp.L309-L312, Part2, No.3B, and 15 March 1998 20 micrometers (Epitaxially laterally overgrown GaN) of ELOG(s) are formed in the silicon-on-sapphire upper part. After growing up GaN after that until thickness is set to 100 micrometers, the GaN substrate with which about 80-micrometer rearrangement was reduced was obtained by deleting silicon on sapphire, and the nitride semiconductor laser component which comes to carry out two or more laminatings of the nitride semi-conductor layer which serves as laser component structure on this GaN substrate is announced. And this laser component announced the nitride semiconductor laser component which makes possible 10,000 hours or more of continuous oscillation in a room temperature. The same typical sectional view as the laser component shown in drawing 6 at above-mentioned J.J.A.P. was shown. As shown in this drawing 6 , it has the stripe of the ridge configuration which etched selectively and was formed to p mold cladding layer which consists of a p mold contact layer which consists of p-GaN from the superstructure of p-aluminum0.14Ga0.86 N/GaN. It is the nitride semiconductor laser component which the insulator layer which benefits the insulation of a component from SiO2 is formed in the side face of the stripe of the formed ridge configuration, and p electrode is further formed in said stripe upper part, and comes to form a resonance side by cleavage. Furthermore, p pad electrode is formed so that this laser component may cover p electrode. Thus, by forming the insulator layer in the side face of the stripe of a ridge configuration, prevention of a short circuit and prevention of leakage current are performed.

[0003]
[Problem(s) to be Solved by the Invention] However, in the obtained laser component, in spite of being the laser component formed on the same conditions, what has an extremely bad life property arises. As a result of examining many things about the cause that a life property falls extremely, since the insulation of the insulator layer of the side face of the stripe of a ridge configuration was imperfect, leakage current arose and this invention person surmised that it was for a short circuit to occur. To both attain improvement in the yield as if for ** which suited commercializing a laser component to make component properties, such as a life property, good is desired.
[0004] Then, the object of this invention is offering the nitride semiconductor laser component which can make the insulation of a component good, can prevent prevention and a short circuit of leakage current, and can obtain a component with a good life property with the sufficient yield.
[0005]
[Means for Solving the Problem] That is, the configuration of following the (1) - (3) can attain the object of this invention.
(1) It has the component structure of making n mold nitride semi-conductor layer, a barrier layer, and p mold nitride semi-conductor layer coming to grow up at least on a substrate. In the nitride semiconductor laser component which etching comes to form the stripe of a ridge configuration from p mold nitride semi-conductor layer side, and comes to form an insulator layer in the side face of the stripe of said ridge configuration further at least The nitride semiconductor laser component characterized by having the rich layer which contains aluminum or boron at abundance near the front face of the flat surface which is in contact with said insulator layer, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least.
(2) A nitride semiconductor laser component given in the above (1) characterized by coming to form said rich layer in the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least by diffusing aluminum or boron after forming the stripe of a ridge configuration.
(3) A nitride semiconductor laser component given in the above (1) characterized by said rich layer carrying out the ion implantation of aluminum or the boron to the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least, and coming to form it in it after forming the stripe of a ridge configuration.
[0006] That is, by forming the rich layer which make abundance come to contain aluminum or boron toward the interior near [, such as a side face of the stripe of a ridge configuration ,] a front face from a front face , this invention act in multiplication with the insulator layer form in the side face of the stripe of a ridge configuration , and the good insulation of it be attain , and it can offer the nitride semiconductor laser component which become possible [preventing leakage current and a short circuit good] . Furthermore, this invention can also attain improvement in the yield by considering as the laser component which has a rich layer.

[0007] Conventionally, as shown in drawing 6 , the insulating insulator layer is formed in the side face of the stripe of a ridge configuration. However, the case where this insulator layer is not uniform good film will arise, insulation will become imperfect, and a short circuit etc. will occur.
[0008] On the other hand, the result examined variously that this invention person should make the insulation of the part which touches a pad electrode a much more perfect thing, Make aluminum (aluminum) or boron (B) contain near the front face of the flat surface which is continuing from the side face of a stripe, and the side face of a stripe in abundance, and a rich layer is formed. By making into insulation the front face of the component structure exposed by forming the stripe of a ridge configuration itself, a rich layer and an insulator layer can act in multiplication, and can have good insulation.
[0009] furthermore, the thing make for front faces, such as a side face of the stripe of a ridge configuration expose, to diffuse aluminum or boron after a rich layer forming the stripe of a ridge configuration in this invention -- or when it come to be form by carrying out the ion implantation of aluminum or the boron, while being able to form a rich layer good and showing better insulation, it be desirable in respect of improvement in the yield.
[0010] Moreover, in this invention, when an ion implantation is carried out, the refractive index of the part is desirable in aluminum or B, also at diffusion or the point which becomes small and light shuts up. From this, although the laser component of drawing 6 is an effctive-index waveguide mold since p electrode has not touched all over the front face of p mold contact layer, for example An ion implantation is spread or carried out. aluminum or B to the side face of a barrier layer 9 for the laser component of drawing 6 , as shown in drawing 1 By forming the rich layer 201, it becomes a perfect refractive-index waveguide mold because slight optical closing depth becomes good, and the level transverse mode can be stable, lifting of a threshold can be prevented, a life property can be raised, and it is desirable.
[0011]
[Embodiment of the Invention] Drawing 1 - drawing 4 are used for below, and this invention is further explained to it at a detail. Drawing 1 is the typical sectional view showing the part cut at right angles to the die-length direction of the stripe of the ridge configuration of the nitride semiconductor laser component which is the gestalt of the 1 operation which comes to form the rich layer 201 of this invention in the laser component of drawing 6 shown with said conventional technique. Drawing 2 - drawing 4 are the typical sectional views of the nitride semiconductor laser component which is the gestalt of the 1 operation which comes to form the rich layer 201 of this invention in the laser component used as a perfect refractive-index waveguide mold.
[0012] The nitride semiconductor laser component of this invention has the rich layer which contains aluminum or boron at abundance near the front face of the flat surface which is in contact with the insulator layer, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least in the nitride semiconductor laser component which comes to form an insulator layer in the side face of the stripe of a ridge configuration. Therefore,

especially as a laser component which forms a rich layer, it is not limited but, specifically, the laser component of drawing 1 - drawing 4 is mentioned that what is necessary is just the laser component which has the stripe of a ridge configuration.
[0013] First, the rich layer 201 is explained using drawing 1 . An insulator layer is formed in the side face of the stripe of a ridge configuration at drawing 1 , the p electrode 20 is formed in the maximum upper layer of a stripe, and p pad electrode is formed in the upper part part of a stripe so that p electrode and an electric target may be contacted. And the rich layer 201 is formed near the front face of the flat surface which is continuing from the side face of the stripe of a ridge configuration in which the insulator layer 62 is in contact with component structure, and the side face of a stripe. after protect formation of the rich layer 201 in the case of this drawing 1 so that the rich layer 201 may not be form in the maximum top face (front face of p mold contact layer) of p mold nitride semi-conductor layer , after form the stripe of a ridge configuration , it be make to contain near the front face which be have aluminum or B expose by diffusion and the ion implantation in abundance in the process of formation of the conventional component .
[0014] In this invention, near a front face shows the part which has the depth toward the inside from the front face of the exposed component structure, after forming the stripe of a ridge configuration. For example, the part in which the rich layer 201 shown in drawing 1 -4 is formed is shown. Moreover, in this invention, though it is the same layer as containing in abundance like p mold contact layer of drawing 2 , and p mold cladding layer, more aluminum or B than other parts are contained, and the condition that aluminum and B are unevenly distributed is shown. And the part in which aluminum and B are unevenly distributed is used as the rich layer 201 by this invention.
[0015] In this invention, after formation of the rich layer 201 forms the stripe of a ridge configuration, it is formed in the exposed part by making aluminum or B contain near the front face of the part where especially p pad electrode is formed in an upper part part at abundance. Especially as an approach of making abundance containing aluminum and B, although not limited, after making a part to form a rich layer in vapor-deposit aluminum and B, in this invention, the method of applying and diffusing heat or the approach by the ion implantation is mentioned, for example as a desirable example.
[0016] In this invention, it heat-treats by making the part to diffuse vapor-deposit aluminum or B as an approach of diffusing. As temperature in the case of heat treatment, it is adjusted suitably, for example, is 400 degrees C - 700 degrees C. As time amount of heat treatment, it is adjusted suitably, for example, is 10 minutes - 2 hours. Moreover, when forming the rich layer 201 by diffusion, adjustment of concentration and accommodation of the depth from a front face are performed by adjusting the temperature and time amount of heat treatment.
[0017] aluminum or B which the mask of the part to make it pouring in was carried out [B], and made it ionize all over a wafer by Si oxide film or the resist as an approach of carrying out an ion implantation in this invention -- 10- it is carried out by accelerating to the energy of hundreds keV(s) and devoting oneself to a

front face. Moreover, when forming the rich layer 201 by the ion implantation, adjustment of concentration and accommodation of the depth from a front face are performed by adjusting impregnation time amount in acceleration voltage.
[0018] Moreover, it is extent which is limited and can take **** and insulation especially as aluminum of the rich layer 201, or concentration of B, for example, they are specifically three or more 1x1014 atom/cm. Moreover, although especially the thickness (depth from a front face) of the rich layer 201 is not limited, it is extent which can take insulation, for example, is specifically 100A - 2 micrometers.

[0019] for example, as a gestalt of 1 implementation of formation of the ridge layer 201 On a substrate as indicated by J.J.A.P. shown with said conventional technique n mold contact layer, From p mold nitride semi-conductor layer side after forming the component structure of making a barrier layer, p mold contact layer, etc. coming to grow up, by etching etc. After forming the stripe of a ridge configuration, Where a rich layer is made not to be formed in the front face of the maximum upper layer of the stripe of a ridge configuration, (in for example, the condition that protective coats, such as a resist formed on the occasion of etching, are formed) The ridge layer 201 is formed at least by the diffusion and the ion implantation which are exposed and which were shown in the side face of the stripe of a ridge configuration etc. above. Then, an insulator layer 15, the p electrode 20, and p pad electrode 101 grade are formed like said J.J.A.P. etc. And it becomes the laser component which has the rich layer 201 shown in drawing 1 . Especially as an insulator layer 62 of drawing 1 , although not limited, SiO2 grade can be used. Moreover, especially as a stripe of the ridge configuration of drawing 1 , although not limited, the content indicated by J.J.A.P. shown above, for example and the same content are mentioned.
[0020] By forming the rich layer 201, the rich layer 201 and an insulator layer 15 act in multiplication, insulation becomes good, and the laser component shown in drawing 1 can perform prevention of leakage current, and prevention of a short circuit, and turns into a laser component with a good life property. In case the laser component furthermore shown in drawing 1 can be produced with the sufficient yield and mass-produced, it is desirable. Since insulation becomes good [the laser component of this invention], furthermore, the desirable laser component shown in drawing 1 again also in respect of the improvement in the dependability of a component (defect prevention) Although nonuniformity arises in current density inside the stripe of a ridge configuration, the level transverse mode becomes unstable and lifting of a threshold may be seen in the condition of not forming the rich layer 201 since p electrode has not touched all over the front face of p mold contact layer A component property like the laser component of a perfect refractive-index waveguide mold becomes easy to be shown by the refractive index of the part becoming small by making aluminum or B contain, and slight optical closing depth becoming good. Thus, if lifting of a threshold is suppressed, a life property can be made more into fitness. The rich layer 201 shown in drawing 1 can adjust thickness by adjusting suitably according to the diffusion at the time of forming the rich layer 201, or the conditions of an ion implantation, although horizontal thickness differs from vertical thickness to a

substrate. The thickness of a rich layer shows whether aluminum or B has entered to the depth of how much in component structure here.
[0021] Next, the laser component of drawing 2 - drawing 4 is explained. By the whole surface surface of p mold contact layer having touched p electrode, since stripe width of face is narrow, the level transverse mode stabilizes drawing 2 - drawing 4 , since they can suppress lifting of a threshold, they are desirable, and they serve as still more desirable structure as a laser component of a perfect refractive-index waveguide mold. Laminating growth of n mold contact layer 5 - the p mold contact layer 13 is carried out on a substrate at drawing 2 - drawing 5 . The stripe of a ridge configuration is formed by etching from this p mold contact layer side. As the 2nd protective coat 62 (insulating film equivalent to the insulator layer of this invention) is formed in the side face of the stripe of a ridge configuration and p mold contact layer which is the maximum upper layer of a stripe is touched, they are p electrode and the laser component which p pad electrode is formed and becomes so that p electrode may be touched further. Here, although the 2nd protective coat 62 is formed in order to be the insulating film, to be equivalent to the insulator layer of this invention and to maintain the insulation of a component like the insulator layer 15 of drawing 1 , it is faced explaining the phase of formation of drawing 2 - drawing 5 , and let it be the 2nd protective coat 62. And the rich layer 201 of this invention is formed in the flat surface which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe as shown in each drawing at such drawing 2 - drawing 5 . By forming the rich layer 201, insulation is shown, it acts in multiplication with the 2nd insulating protective coat 62 currently formed in the side face of a stripe, and the part of the rich layer 201 also makes the insulation of a component good. Prevention of leakage current and prevention of a short circuit become good, and the improvement in a life property and improvement in the yield can be attained because insulation becomes good.
[0022] Especially as the 2nd protective coat 62 used as the insulator layer used for drawing 2 - drawing 5 , although not limited, the oxide which contains at least a kind of element chosen from the group which consists of Ti, V, Zr, Nb, Hf, and Ta, BN, SiC, AlN, etc. are mentioned, for example. Moreover, Si oxide can also be used as the 2nd protective coat 62, and it is carried out by choosing the ingredient which is easy to be etched from Si oxide as an ingredient of the 1st protective coat 61 in this case as mentioned later as mentioned later.
[0023] Especially as stripe geometry of drawing 2 - drawing 5 , although not limited, as desirable stripe geometry, the stripe geometry whose stripe width of face is 0.5-4.0 micrometers, for example can be raised. Stripe width of face is desirable in respect of the lowering of a threshold and the stabilization of the level transverse mode by it being the above-mentioned range. Moreover, as stripe width of face described above as a laser component which has the stripe of structure narrow as mentioned above, the laser component of structure as shown in drawing 2 - drawing 4 is mentioned. Even if these laser components narrow stripe width of face, they are obtained by the stripe and the electrode formation approach (specifically indicated by JP,2000-4063,A.) of forming with sufficient repeatability. Drawing 5 is used and explained about the approach below. By choosing an

ingredient so that the etch rates by etching processing with the 1st protective coat 61 used in case the waveguide of a stripe is formed, and the 2nd insulating protective coat 62 formed in the side face of a stripe may differ, and performing following each process, this approach can form a stripe with sufficient repeatability, and can form the 2nd insulating protective coat 62 in a position by the thickness of homogeneity further.
[0024] Drawing 5 is the typical sectional view showing the partial structure of the nitride semiconductor wafer in each process for explaining each process of the stripe of the nitride semiconductor laser component of drawing 2 - drawing 4 , and the formation approach of an electrode. The sectional view shown in this drawing 5 shows drawing at the time of it being parallel and cutting to a perpendicular direction, i.e., a resonance side, to the stripe waveguide formed by etching.
[0025] First, in the 1st process, as shown in drawing 5 (c), the stripe-like 1st protective coat 61 is formed on p mold contact layer 13 in the maximum upper layer. In this 1st process, as long as the 1st protective coat 61 is an ingredient which does not ask especially insulation but has the etch rate and difference of a nitride semi-conductor, what kind of ingredient is sufficient as it. As the 1st protective coat 61, although choosing and using the ingredient with which the 2nd protective coat 62 formed at the 3rd below-mentioned process differs from an etch rate forms the 2nd protective coat 62, it is still more desirable. As the 1st protective coat 61, for example, Si oxide (SiO_2 is included), a photoresist, etc. are mentioned, and it is Si oxide preferably. Although wet etching, dry etching, etc. are used as an approach it will form the waveguide field of the shape of a stripe of the nitride semiconductor laser component in the 2nd following process if the 1st protective coat 61 is Si oxide, the dry etching which etching tends to carry out is used preferably, and can make good selectivity of the 1st protective coat 61 and nitride semi-conductor to which importance is attached by this dry etching. Moreover, it is easy to dissolve to fluoric acid and is desirable when fluoric acid is used as an acid which has the property which is easy to dissolve rather than the 2nd protective coat by etching which will be performed using an acid at the 3rd process which is an after process if the 1st protective coat 61 is chosen from the above-mentioned ingredient to an acid, is easy to establish a solubility difference with the 2nd protective coat 62, and is used especially at the 3rd process. As stripe width of face (W) of the 1st protective coat, 4 micrometers - 0.5 micrometers are preferably adjusted to 3 micrometers - 1 micrometer. The stripe width of face of the 1st protective coat 61 is about equivalent to the stripe width of face of a waveguide field.
[0026] In the 1st process, the process shown in drawing 5 (a) and (b) is mentioned as a concrete process which forms the 1st protective coat 61. First, as shown in drawing 5 (a), after [the front face of p mold contact layer 13] forming in the whole surface mostly, the stripe-like 3rd protective coat 63 is formed for the 1st protective coat 61 on the 1st protective coat 61. Then, as shown in drawing 5 (b), after etching the 1st protective coat 61, with the 3rd protective coat 63 attached, the 1st protective coat 61 of the shape of a stripe as shown in drawing 5 (c) can be formed by removing the 3rd protective coat 63. In addition, etching gas or an etching means can be changed with the 3rd protective coat 63 attached, and it can

also etch from p mold contact layer 13 side.
[0027] In the 1st process, in order to be able to use dry etching like RIE (reactive ion etching), for example and to etch the 1st protective coat 61 which consists of Si oxide at the 1st process in this case as an etching means, it is desirable to use the gas of a fluorine compound system like CF4.
[0028] Moreover, the 1st protective coat 61 of the shape of a stripe as shown in drawing 5 (c) can also be formed by the lift-off method. By the lift-off method, by forming the photoresist of the configuration which the stripe-like hole opened on p mold contact layer 13, forming the 1st protective coat 61 the whole surface from the photoresist, and carrying out dissolution clearance of the photoresist after that, as shown in drawing 5 (c), it leaves only the 1st protective coat 61 in contact with p mold contact layer 13. In addition, as an approach of forming the 1st protective coat 61, it is in the inclination for the stripe with which an end face is [to form by etching, as shown in drawing 5 (a) and (b)] almost more nearly vertical, and the configuration was ready to be easy to be obtained rather than it forms the stripe-like 1st protective coat 61 by the lift-off method.
[0029] Next, in the 2nd process, as shown in drawing 5 (d), it etches from the part in which the 1st protective coat 61 of p mold contact layer 13 in which the 1st protective coat 61 was formed is not formed, and the waveguide field of the shape of a stripe according to the configuration of a protective coat is formed in a part for the direct lower part of the 1st protective coat 61. When etching, the structure of a laser component differs from a property by into which location a dirty stop is made. As long as a dirty stop is a layer below p mold contact layer, it may be stopped in any nitride semi-conductor layer. In the example shown in drawing 5 , the middle of p mold cladding layer 12 under p mold contact layer 13 is considered as the dirty stop. If a substrate side is a dirty stop from the soffit side of p mold cladding layer rather than the 0.2 micrometers of the directions of p mold contact layer, a stripe will serve as a ridge and the laser component of a refractive-index waveguide mold will be made. A soffit side points out the field of the bottom cladding layer to the thickness direction, and as stated also in advance, when a lightguide layer is under a cladding layer, the interface of a guide layer and a cladding layer is equivalent to a soffit side. If a dirty stop is carried out above this soffit side, since etching time will become short and it will be easy to control an etching rate, convenience on industrial engineering is good.
[0030] Moreover, a dirty stop can also be used as the nitride semi-conductor below the soffit side of p mold cladding layer although not shown in drawing 5 . When the layer by the side of a substrate is a dirty stop, it is [an inclination for a threshold to fall remarkably] and is more desirable than a soffit side.
[0031] In the 2nd process, as an etching means, although wet etching, dry etching, etc. are used, the dry etching which etching tends to carry out is used preferably. For example, if dry etching like RIE (reactive ion etching) can be used, the gas of a chlorine system like Cl2, CCl4, and SiCl4 used well at other groups III-V semiconducter to etch a nitride semi-conductor in this case is used and these gas is used, when Si oxide is used as the 1st protective coat 61, since a selection ratio with Si oxide is made greatly, it is desirable.
[0032] After etching as shown in (d) of drawing 5 , and forming the stripe of a ridge

configuration, the rich layer 201 is formed. The approach of formation of the rich layer 201 is as having described above. The condition of having formed vacuum evaporationo film, such as aluminum, in the flat surface which is continuing from the side face of the stripe of a ridge configuration and its side face by vacuum evaporationo is shown in drawing 5 (e-1). Abundant parts, such as aluminum, are formed toward the interior after forming vacuum evaporationo film, such as this aluminum, from the front face of the component structure which is in contact with vacuum evaporationo film, such as aluminum, with thermal diffusion. Then, the rich layer 201 can be formed by removing vacuum evaporationo film, such as aluminum, as shown in drawing 5 (e-2).

[0033] Next, in the 3rd process, after forming the rich layer 201, as shown in drawing 5 (f), it is an ingredient which is different from the 1st protective coat 61 in the 2nd protective coat 62, and forms using the ingredient which has insulation on the side face of stripe-like waveguide, the flat surface of the nitride semi-conductor layer (drawing 5 (f) p mold cladding layer 12) which it was etched and was exposed, and the 1st protective coat 61. After forming the 2nd protective coat 62, by removing the 1st protective coat 61 by etching, only the 2nd protective coat 62 formed on the 1st protective coat 61 is removed, and as shown in drawing 5 (g), the 2nd protective coat 62 is continuously formed in the side face of a stripe, and the flat surface of p mold cladding layer 12. Thus, in order to make it possible to remove the 1st protective coat 61, without etching the 2nd protective coat 62, as described above, it becomes possible by choosing and using that from which the etch rate to the etching processing performed at the 3rd process differs the ingredient of the 1st protective coat 61 and the 2nd protective coat 62. Although especially etching processing at the 3rd process is not limited, the approach of carrying out dry etching, for example using fluoric acid is mentioned.

[0034] It is chosen from a different ingredient from the 1st protective coat 61 as an ingredient of the 2nd protective coat 62, and it will not be limited, especially if it is the ingredient which is hard to be etched by etching processing of the 3rd process or an etch rate is slower than the 1st protective coat 61 and is the ingredient which can form the 2nd protective coat 62 in the side face of a stripe etc. As the 2nd desirable protective coat, from Si oxide and a resist ingredient being preferably used as the 1st protective coat 61 as mentioned above, it is ingredients other than the ingredient of the 1st protective coat 61 at least, and an ingredient with an etch rate slower than the 1st protective coat 61 is mentioned. When the 1st protective coat 61 is Si oxide, a kind is used for inside [it is the oxide which contains at least a kind of element chosen from the group which consists of Ti V, Zr, Nb, Hf, and Ta, for example as an example of the 2nd protective coat 62, and BN, SiC and AlN] at least, and the oxide of Zr, the oxide of Hf, and any one or more sorts of ingredients of BN and SiC are used more preferably. Moreover, after the 2nd protective coat 62 formation, in order not to etch a nitride semi-conductor, the 2nd protective coat 62 is not taken into consideration about etching speed with a nitride semi-conductor. Moreover, as 2nd thin film layer 62, Si oxide may be used and the 1st protective coat 61 is performed in this case by choosing an ingredient with the etch rate quicker than Si oxide in the 3rd process.

[0035] Moreover, like the above, by continuing and forming the 2nd protective coat on the 1st protective coat 61, high insulation can be held, and since it can form by uniform thickness on p mold cladding layer 12, generating of concentration of the current resulting from the ununiformity of thickness can be prevented. Moreover, in the 2nd process of the above, since the dirty stop is considered as the middle of p mold cladding layer 12, as the 3rd process shows to drawing 5 (f), the 2nd protective coat 62 is formed in the flat surface of p mold cladding layer 12, but if a dirty stop is carried out below p mold cladding layer 12, the 2nd protective coat will be formed in the flat surface of the nitride semi-conductor layer which carried out the dirty stop.
[0036] Moreover, the 2nd protective coat 62 can also be formed by the lift-off method. For example, it is either of the examples which the 2nd protective coat 62 described above, and if the 1st protective coat 61 is used as Si oxide, the 2nd protective coat 62 has the etch selectivity of being hard to be etched or an etch rate is slower than Si oxide, to fluoric acid. For this reason, if only the 1st protective coat 61 is removed by the lift-off method after forming the 2nd protective coat succeeding the side face of stripe waveguide, the flat surface (dirty stop layer) in which that stripe is formed, and the front face of the 1st protective coat 61, as shown in drawing 5 (f), the 2nd protective coat 62 with uniform thickness will be formed to a flat surface as shown in drawing 5 (g).
[0037] Next, in the 4th process, as shown in drawing 5 (h), the p electrode 20 electrically connected with the p mold contact layer 13 is formed on the 2nd protective coat 62 and p mold contact layer 13. Here, since the 2nd protective coat 62 is already formed of said process, in case p electrode is formed, there is no need for fine actuation of forming only in the narrow contact layer of stripe width of face, p electrode can be formed by the large area and operability becomes good.
[0038] moreover, in this invention, when it may have the stripe of the ridge configuration where the above width of face is narrow, as a p pad electrode formed on p electrode The 1st thin film layer which contains the metal which covered whole p electrode surface and was formed by the same die length as stripe die length desirable at least although not limited especially, this -- when it is formed from the 2nd thin film layer containing the metal formed by die length shorter than stripe die length on the 1st thin film layer or comes to form the 3rd thin film layer between the 1st and the 2nd thin film layer, it is desirable, although the cleavability of p pad electrode improves and exfoliation of p electrode is prevented. For example, p pad electrode 101 which comes to form the 2nd thin film layer 32 on the 1st thin film layer 31 shown in drawing 2 used in the below-mentioned example is mentioned.
[0039] The 1st thin film layer is desirable in respect of heat dissipation nature etc. to cleavability, an adhesive property, and a pan in their being more than kinds, such as nickel, Ti, Cr, W, and Pt. Moreover, when the 2nd thin film layer consists of Au, the heat conductivity becomes it is good and good [stripping of heat], and it is still more desirable in respect of the adhesive property in the case of bonding, relaxation of an impact, etc. Although the 2nd thin film layer which consists of Au is inferior in cleavability, since it is a configuration shorter than stripe die length,

the end face of the 2nd thin film layer is not in agreement with the cleavage plane formed of cleavage, and does not affect the cleavability of p pad electrode at all. Moreover, when the 3rd thin film layer containing at least one or more sorts of ingredients, such as Pt, W, TiN, Cr, and nickel, is formed between the 1st thin film layer and the 2nd thin film layer, it can prevent that the 3rd thin film layer turns into a barrier layer, and the metal of the 2nd thin film layer is spread, and is desirable. Thus, when diffusion of the 2nd thin film layer can be prevented, it is desirable for lifting of resistance and lifting of a threshold being suppressed, and generating of the heat inside a laser component being prevented by it, and raising a life property.

[0040] In this invention, the electrode which has the ohmic contact which can choose various ingredients suitably, and can use them as p and an n electrode, for example, is indicated by said J.J.A.P. is mentioned.

[0041] Moreover, in order to be obstructed by n electrode, and for a scribe not to attain even a nitride semi-conductor and to prevent this trouble if SUKURAIBUSU [a substrate rear face / solid one / n electrode] from an after [formation] rear face when n electrode is formed in a substrate rear face, by forming n electrode of a pattern configuration in the substrate rear face of a wafer, it becomes easy to carry out a scribe and cleavability improves. the configuration of one chip obtained by carrying out cleavage of the wafer as a pattern configuration is easy to be acquired -- as -- a configuration almost comparable as a chip size, for example, a 400micrometerx400micrometer configuration, -- it comes out and a certain thing is desirable. That is, a pattern is attached and n electrode is formed so that n electrode may not exist on a scribe line and/or a cleavage plane. Furthermore, if a metallizing electrode is also formed on n electrode in the same pattern configuration as n electrode, it will become easy to carry out the scribe of it, and its cleavability will improve. Especially as an n electrode, although not limited, Ti-aluminum, W-aluminum-W-Au, etc. can be used, for example. As a metallizing electrode, 0.1 micrometer-0.2micrometer[of Ti-Pt-Au-(Au/Sn) [thickness]-0.7micrometer-0.3micrometer], Like the Ti-Pt-Au-(Au/Si) [thickness above, like] and the Ti-Pt-Au-(Au/germanium) [thickness above],] etc. can be used like] and the Au/germanium[thickness above like] and the Au/Si[thickness above like] and the [0.3 micrometers of Au/Sn thickness] In[thickness above like the Ti-Pt-Au-In [thickness above. As the approach of chip-izing in case n electrode is formed in a rear face at a pattern configuration, a bar-like sample can be produced for between n electrode patterns on the back by the scribe from a rear face, and a scribe can perform chip-ization from the rear face after reflective mirror formation to an end face, for example.

[0042] Moreover, especially as component structure of others of the laser component of this invention, it is not limited but well-known various component structures can be used. or [that the nitride semi-conductor of SiO2 grade does not grow on different-species substrates known conventionally, such as sapphire and a spinel, or a different-species substrate as a substrate into which the component structure of the laser component of this invention is grown up] -- or the protective coat which consists of an ingredient which cannot grow easily forms, and the nitride semi-conductor substrate which is made to carry out lateral

growth (lateral growth) selectively on it, and is obtained is mentioned. A nitride semi-conductor substrate with few crystal defects which are made to carry out lateral growth preferably and are acquired is desirable. When component structure is formed on a nitride semi-conductor substrate with few crystal defects, it is desirable, although the crystal defect of the nitride semi-conductor which constitutes a component decreases and generation of heat within a component is suppressed. Moreover, it becomes easy to carry out cleavage of the substrate to being a nitride semi-conductor substrate, and it is desirable also in respect of peeling prevention of p electrode. The protective coat used when the protective coat used for lateral growth formed said stripe shows a different operation.
[0043] As the growth approach of a nitride semi-conductor substrate with few crystal defects acquired using lateral growth Although it may not be limited but which approach may be used, especially, for example An approach given in J.J.A.P.Vol.37(1998) pp.L309-L312, The concavo-convex section is formed in the nitride semi-conductor front face which these people grew up on a different different-species substrate from the nitride semi-conductor currently indicated by JP,11-191659,A which applied previously. After forming said protective coat of SiO2 grade on the flat surface of the heights and a crevice, the method of connecting the nitride semi-conductor which grew the longitudinal direction and grew up to be the protective coat upper part in the longitudinal direction mutually from the nitride semi-conductor exposed to the side face etc. is mentioned. Moreover, in case the nitride semi-conductor substrate obtained with lateral growth grows up component structure, even if it performs it in the condition of having a different-species substrate, where a different-species substrate is removed, it may be performed.
[0044] The resonance side of the laser component of this invention can form a good mirror plane-like resonance side by carrying out cleavage in respect of {11-00} of a nitride semi-conductor [the field equivalent to the side face of a Mth page:hexagonal prism-like crystal] so that it may become vertical to the stripe of a ridge configuration. The detail is indicated about the cleavage in the Mth page of a nitride semi-conductor by JP,9-232676,A for which these people applied previously, for example.
[0045]
[Example] The example of the nitride semiconductor laser component which is the gestalt of 1 operation of the following this inventions is shown. However, this invention is not limited to this.
[Example 1] drawing 2 is the typical sectional view showing the structure of the laser component concerning one example of this invention, and shows drawing at the time of cutting in a direction vertical to stripe waveguide. Hereafter, an example 1 is explained based on this drawing.
[0046] (Substrate layer 2) The different-species substrate 1 which consists of sapphire which makes 1inchphi and C side a principal plane is set in a MOVPE reaction container, temperature is made into 500 degrees C, and the buffer layer which consists of GaN is grown up by 200A thickness using trimethylgallium (TMG) and ammonia (NH3). Temperature is made into 1050 degrees C after buffer layer growth, and the substrate layer 2 which similarly consists of GaN is grown up by 4-

micrometer thickness. This substrate layer forms a protective coat in a front face selectively, and acts as a substrate layer for next performing selective growth of a nitride semi-conductor substrate.
[0047] (Protective coat 3) The protective coat 3 which forms a stripe-like photo mask in the front face of ejection and this substrate layer from a reaction container, and consists a wafer of SiO2 with a stripe width of face [of 10 micrometers] and a stripe spacing (window part) of 2 micrometers with PVD equipment is formed after substrate layer growth.
[0048] (Nitride semi-conductor substrate 4) A wafer is again set in the reaction container of MOVPE after protective coat formation, temperature is made into 1050 degrees C, and the nitride semi-conductor substrate 4 which consists of undoping GaN is grown up by 20-micrometer thickness using TMG and ammonia. The double or more figures crystal defect of this nitride semi-conductor substrate decreases as compared with 2 or less [105 //cm] and substrate layers 2 in order to grow up to be a longitudinal direction in the protective coat 3 upper part.
[0049] (n mold contact layer 5) Next, n mold contact layer 5 which consists of GaN which doped Si 3x1018-/cm3 at 1050 degrees C on the nitride semi-conductor substrate 1 is grown up by 4-micrometer thickness, using silane gas as ammonia, TMG, and impurity gas.
[0050] (Crack prevention layer 6) Next, the crack prevention layer 6 which makes temperature 800 degrees C and consists of In0.06Ga0.94N is grown up by 0.15-micrometer thickness using TMG, TMI (trimethylindium), and ammonia. In addition, this crack prevention layer is omissible.
[0051] (n mold cladding layer 7) Then, the layer which consists of undoping aluminum0.16Ga0.84N using TMA (trimethylaluminum), TMG, and ammonia at 1050 degrees C is grown up by 25A thickness, TMA is stopped continuously and the layer which consists of an n mold GaN which doped a sink and Si for silane gas 1x1019-/cm3 is grown up by 25A thickness. Crosswise lamination of those layers is carried out, a superlattice layer is constituted, and n mold cladding layer 7 which consists of superlattice of the 1.2 micrometers of the total thickness is grown up.
[0052] (n mold lightguide layer 8) Then, n mold lightguide layer 8 which consists silane gas of undoping GaN at a stop and 1050 degrees C is grown up by 0.1-micrometer thickness. n mold impurity may be doped in this n mold lightguide layer 8.
[0053] (Barrier layer 9) Next, temperature is made into 800 degrees C, the barrier layer which consists of Si dope In0.05Ga0.95N is grown up by 100A thickness, and the well layer which consists of undoping In0.2Ga0.8N at the same temperature continuously is grown up by 40A thickness. The laminating of a barrier layer and the well layer is carried out twice alternately, finally it is finished as a barrier layer, and the barrier layer of the multiplex quantum well structure (MQW) of the 380A of the total thickness is grown up.
[0054] (p mold cap layer 10) Next, raising, TMG and TMA, ammonia, and Cp2Mg (magnesium cyclopentadienyl) are used for 1050 degrees C for temperature, and p mold cap layer 7 which consists of p mold aluminum0.3Ga0.7N with larger bandgap energy which doped Mg 1x1020-/cm3 than p mold lightguide layer 11 is grown up by 300A thickness.

[0055] (p mold lightguide layer 11) continuing -- Cp2 -- p mold lightguide layer 11 which bandgap energy becomes from the undoping GaN smaller than p mold cap layer 10 at a stop and 1050 degrees C about Mg and TMA is grown up by 0.1-micrometer thickness.
[0056] (p mold cladding layer 12) then, the layer which consists of undoping aluminum0.16Ga0.84N at 1050 degrees C is grown up by 25A thickness -- making -- continuing -- Cp2 -- the layer which consists Mg and TMA of a stop and undoping GaN is grown up by 25A thickness, and p mold cladding layer 12 which consists of a superlattice layer of the 0.6 micrometers of the total thickness is grown up.
[0057] (p mold contact layer 13) p mold contact layer 13 which finally consists of a p mold GaN which doped Mg 1x1020-/cm3 on p mold cladding layer 9 at 1050 degrees C is grown up by 150A thickness.
[0058] The protective coat which becomes the front face of p mold contact layer of the ejection from a reaction container and the maximum upper layer from SiO2 about the wafer into which the nitride semi-conductor was grown up as mentioned above is formed, and it etches by SiCl4 gas using RIE (reactive ion etching), and as shown in drawing 2 , the front face of n mold contact layer 5 which should form n electrode is exposed. Thus, for etching a nitride semi-conductor deeply, it considers as a protective coat, and SiO2 is the optimal.
[0059] Next, mostly, as shown in drawing 5 (a), after forming the 1st protective coat 61 of p mold contact layer 13 of the maximum upper layer which consists of an Si oxide (mainly SiO2) by 0.5-micrometer thickness with PVD equipment, the mask of a predetermined configuration is covered on the 1st protective coat 61, and the 3rd protective coat 63 which consists of a photoresist is formed in the whole surface by 1 micrometer in stripe width of face of 2 micrometers, and thickness.
[0060] Next, as shown in drawing 5 (b), said 1st protective coat 61 is etched by using the 3rd protective coat 63 as a mask using CF4 gas after the 3rd protective coat 63 formation and with RIE (reactive ion etching) equipment, and it considers as the shape of a stripe. By processing with an etching reagent after that and removing only a photoresist, as shown in drawing 5 (c), the 1st protective coat 61 with a stripe width of face of 2 micrometers can be formed on p mold contact layer 13.
[0061] Furthermore, as shown in drawing 5 (d), after the 1st protective coat 61 formation of the shape of a stripe, p mold contact layer 13 and p mold cladding layer 12 are again etched using SiCl4 gas by RIE, and a stripe-like waveguide field (ridge stripe in this case) is formed. The transverse mode is [that it is easy to become a single mode] dramatically desirable when it is the configuration of an order mesa where the cross-section configuration of the stripe is shown in drawing 2 , in case a stripe is formed.
[0062] Where the film for protecting so that a rich layer may not be formed in p mold contact layer 13, after forming the stripe of a ridge configuration is attached, on the flat surface which is continuing from the side face of the stripe of a ridge configuration, and its side face, aluminum is vapor-deposited with PVD equipment and the vacuum evaporationo film is formed [drawing 5 (e-1)]. Next, in an

annealing furnace, it heat-treats by applying predetermined time amount and heat. Then, an acid removes the vacuum evaporationo film of aluminum. Thus, the rich layer 201 is formed like drawing 5 (e-2).
[0063] A wafer is transported to PVD equipment after forming the rich layer 201, and as shown in drawing 5 (f), the 2nd protective coat 62 which consists of a Zr oxide (mainly ZrO2) is continued and formed by 0.5-micrometer thickness on p mold cladding layer 12 exposed by etching the 1st protective coat 61 top.
[0064] Next, as it is immersed in fluoric acid and a wafer is shown in drawing 5 (g), the 1st protective coat 61 is removed by the lift-off method.
[0065] Next, as shown in drawing 5 (h), the p electrode 20 which consists of nickel/Au is formed in the front face of the p mold contact layer which the 1st protective coat 61 on p mold contact layer 13 was removed, and was exposed. However, as stripe width of face of 100 micrometers, the p electrode 20 is gone across and formed on the 2nd protective coat 62, as shown in this drawing 5 (h).
[0066] Next, succeeding the whole surface on the p electrode 20, the 1st thin film layer 31 which consists of Ti is formed by 1000A thickness, and as further shown in drawing 2 , the 1st thin film layer 31 is formed in the side face of a stripe etc. The upper part of the magnitude which is not in agreement with the cleavage plane at the time of forming a resonance side by cleavage at a next process on this 1st thin film layer 31 formed continuously, i.e., the part used as a cleavage plane, is avoided, the 2nd thin film layer 32 which consists of Au intermittently is formed by 8000A thickness, and p pad electrode 101 which consists of the 1st thin film layer 31 and the 2nd thin film layer 32 is formed.
[0067] The n electrode 21 which consists of Ti/aluminum is formed in the front face of n mold contact layer 5 exposed at the very first in a direction parallel to a stripe after p pad electrode formation, and n pad electrode which consists of Ti/Pt/Au is formed on it.
[0068] After grinding the silicon on sapphire of the wafer which formed n electrode, p electrode, and p pad electrode as mentioned above and being referred to as 70 micrometers, in a direction vertical to a stripe-like electrode, cleavage is carried out to the shape of a bar from a substrate side, and a resonator is produced to a cleavage plane (11 the 00th [-] page, a hexagon head field = equivalent to the side face of a pillar-shaped crystal Mth page). The dielectric multilayer which consists of SiO2 and TiO2 is formed in a resonator side, and, finally it considers as a laser component as cut a bar and shown in drawing 2 in a direction parallel to p electrode. In addition, as for cavity length, it is desirable to be referred to as 300-500 micrometers.
[0069] When this laser component is installed in a heat sink, wire bonding of each electrode is carried out and laser oscillation is tried at a room temperature, in the oscillation wavelength of 400-420nm, and threshold-current consistency 2.9 kA/cm2, a room temperature shows a good continuous oscillation. Furthermore, leakage current and a short circuit can be prevented, a laser component with a good life property can be obtained efficiently, and the yield improves because insulation became good.
[0070] In the [example 2] example 1, the rich layer 201 which consists of aluminum is formed by the ion implantation, and also a laser component is produced similarly.

As the approach of an ion implantation, it is in the condition which attached the protective coat to the maximum top face of p mold contact layer 13, and aluminum is accelerated from a wafer top face to predetermined energy with ion implantation equipment, and it is devoted to a wafer. Next, a carrier beam part is heat-treated and a damage is made to recrystallize by the ion implantation. The obtained laser component shows a good component property like an example 1, and its yield also improves further.
[0071] [Example 3] drawing 3 is the typical sectional view showing the structure of the laser component concerning other examples of this invention, and explains an example 3 below based on this drawing.
[0072] (Nitride semi-conductor substrate 40) In an example 1, a wafer is again set to the front face of the substrate layer 2 in the reaction container of MOVPE after stripe-like formation [protective coat 3], temperature is made into 1050 degrees C, and Undoping GaN is grown up by 5-micrometer thickness using TMG and ammonia. Then, a wafer is transported to HVPE (hydride vapor growth) equipment, Ga metal, HCl gas, and ammonia are used for a raw material, and the nitride semi-conductor substrate 40 which consists of undoping GaN is grown up by 200-micrometer thickness. thus, MOVPE -- HVPE after growing up a nitride semi-conductor on a protective coat 3 by law -- if a GaN thick film 100 micrometers or more is grown up by law, even if it compares a crystal defect with an example 1, it will be acquired, and will decrease single or more figures. After nitride semi-conductor substrate 40 growth, polish removes the ejection from a reaction container, silicon on sapphire 1, a buffer layer 2, a protective coat 3, and an undoping GaN layer, and let a wafer be independent [nitride semi-conductor substrate 40].
[0073] The rest carries out the laminating even of n mold contact layer 5 - the p mold contact layer 13 on the nitride semi-conductor substrate 40 of an opposite hand a polish side like an example 1.
[0074] Like an example 1 after p mold contact layer 13 growth, let an etching stop be the front face of n mold contact layer 5 in the 2nd process after forming the stripe-like 1st protective coat 61. The rest forms an electrode in each contact layer, after forming in the side face of stripe waveguide, and the front face of n mold contact layer 5 the 2nd protective coat 62 which uses ZrO2 as a principal component after forming the rich layer 201 which consists of aluminum like an example 1. Next, p pad electrode 101 is formed like an example 1, and it considers as the laser component of structure as shown in drawing 3 . In addition, when forming a resonance side, the cleavage plane of a nitride semi-conductor substrate may be the Mth same page as an example 1. A threshold-current consistency falls [the obtained laser component] even to 1.8 kA/cm2 as compared with an example 1, a life can improve by 3 or more times, leakage current and a short circuit can prevent good by insulating improvement still like an example 1, and the laser component which has a good life property can be produced with the sufficient yield.
[0075] [Example 4] drawing 4 is the typical sectional view showing the structure of the laser component concerning other examples of this invention, and explains an example 4 using this drawing 4 below.

[0076] In an example 3, in case the nitride semi-conductor substrate 40 is produced, in HVPE equipment, silane gas is added to a raw material, and the nitride semi-conductor substrate 50 which consists of GaN which doped Si 1x1018-/cm3 is grown up by 200-micrometer thickness. In addition, as for Si concentration, it is desirable to consider as the range of three to 5x1019/cm3 of 1x1017-/cm. Silicon on sapphire 1, a buffer layer 2, a protective coat 3, and an undoping GaN layer are ground and removed like an example 3 after nitride semi-conductor substrate 50 growth, and it considers as nitride semi-conductor substrate 50 simple substance.
[0077] Next, laminating growth even of the crack prevention layer 6 - the p mold contact layer 13 is carried out like an example 1 on this nitride semi-conductor substrate 50. Like an example 1 after p mold contact layer 13 growth, after forming the stripe-like 1st protective coat 61, in the 2nd process, it considers as the front face of n mold cladding layer 7 which shows an etching stop to drawing 5 . Like an example 1, the rest forms the rich layer 201, and after that, after it forms in the side face of stripe waveguide, and the front face of n mold cladding layer 7 the 2nd protective coat 62 which uses ZrO2 as a principal component, it forms the p electrode 20 through the 2nd protective coat.
[0078] The 1st thin film layer 31 which consists of Ti on the p electrode 21 so that it may become stripe die length and the same die length next, by 1000A of thickness The 3rd thin film layer which consists of Pt in the configuration of the 2nd thin film layer 32, and the same configuration by 1000A of thickness And p pad electrode 101 which comes to carry out laminating formation of the 2nd thin film layer 32 which consists of Au in a configuration shorter than stripe die length by 8000A of thickness at order is formed as shown in drawing 4 . Although the 3rd thin film layer is not illustrated, it forms in the same configuration as the 2nd thin film layer. on the other hand -- the rear-face side of a nitride semi-conductor substrate -- the n electrode 21 is mostly formed in the whole surface. After electrode formation, cleavage is carried out by the Mth page of a nitride semi-conductor substrate, and a resonance side is produced and it considers as the laser component of structure as shown in drawing 4 .
[0079] [Example 5] As shown in the laser component of drawing 6 which shows the laser component indicated by said J.J.A.P. at drawing 1 , the laser component which comes to form the rich layer 201 like an example 1 is produced. Insulation can become good, and the obtained laser component can prevent generating of leakage current, and generating of a short circuit, and can produce a component with a good life property with the sufficient yield.
[0080] In the [example 6] example 1, the laser component which has it come to form the rich layer 201 which change to aluminum, and B is used, and also contains B in abundance by diffusion similarly is produced. Consequently, a good result almost equivalent to an example 1 is obtained.
[0081] In the [example 7] example 2, the laser component which has it come to form the rich layer 201 which change to aluminum, and B is used, and also contains B in abundance by the ion implantation similarly is produced. Consequently, a good result almost equivalent to an example 1 is obtained.
[0082]
[Effect of the Invention] The nitride semiconductor laser component of this

invention can produce the laser component which an insulator layer (the 2nd protective coat is included) and a rich layer act in multiplication , and has good insulation by forming the rich layer which contains aluminum or B in abundance near the front face of the flat surface which is continuing as mentioned above from the side face of the stripe of the rich configuration of component structure , and its side face . And prevention can prevent prevention and a short circuit of leakage current, and a laser component with a good life property can be obtained with the sufficient yield. Furthermore, according to the condition of formation of a rich layer, this invention can make slight optical closing depth good, becomes possible [changing into the component structure of a perfect refractive-index mold], even if it is the component structure of an effctive-index mold, and serves as a desirable laser component in respect of stabilization of the level transverse mode, or lowering of a threshold.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] Especially insulation of this invention is good about the laser component which consists of a nitride semi-conductor (InaAlbGa1-a-bN, 0<=a, 0<=b, a+b<=1), and it is related with the long nitride semiconductor laser component of the life from which leakage current and a short circuit were prevented.

[Translation done.]

PRIOR ART

[Description of the Prior Art] In recent years, many researches and developments are done for utilization of a nitride semiconductor laser component, and various nitride semiconductor laser components are known. this invention person etc. as a usable laser component for example, to Jpn.J.Appl.Phys.Vol.37(1998) pp.L309-L312, Part2, No.3B, and 15 March 1998 20 micrometers (Epitaxially laterally overgrown GaN) of ELOG(s) are formed in the silicon-on-sapphire upper part. After growing up GaN after that until thickness is set to 100 micrometers, the GaN substrate with which about 80-micrometer rearrangement was reduced was obtained by deleting silicon on sapphire, and the nitride semiconductor laser component which comes to carry out two or more laminatings of the nitride semi-conductor layer which serves as laser component structure on this GaN substrate is announced. And this laser component announced the nitride semiconductor laser component which makes possible 10,000 hours or more of continuous oscillation in a room temperature. The same typical sectional view as the laser component shown in drawing 6 at above-mentioned J.J.A.P. was shown. As shown in this drawing 6 , it has the stripe of the ridge configuration which etched selectively and was formed to p mold cladding layer which consists of a p mold contact layer which consists of p-GaN from the superstructure of p-aluminum0.14Ga0.86 N/GaN. It is the nitride semiconductor laser component which the insulator layer which benefits the insulation of a component from SiO2 is formed in the side face of the stripe of the formed ridge configuration, and p electrode is further formed in said stripe upper part, and comes to form a resonance side by cleavage. Furthermore, p pad electrode is formed so that this laser component may cover p electrode. Thus, by forming the insulator layer in the side face of the stripe of a ridge configuration, prevention of a short circuit and prevention of leakage current are performed.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The nitride semiconductor laser component of this invention can produce the laser component which an insulator layer (the 2nd protective coat is included) and a rich layer act in multiplication , and has good insulation by forming the rich layer which contains aluminum or B in abundance near the front face of the flat surface which is continuing as mentioned above from the side face of the stripe of the rich configuration of component structure , and its side face . And prevention can prevent prevention and a short circuit of leakage current, and a laser component with a good life property can be obtained with the sufficient yield. Furthermore, according to the condition of formation of a rich layer, this invention can make slight optical closing depth good, becomes possible [changing into the component structure of a perfect refractive-index mold], even if it is the component structure of an effctive-index mold, and serves as a desirable laser component in respect of stabilization of the level transverse mode, or lowering of a threshold.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, in the obtained laser component, in spite of being the laser component formed on the same conditions, what has an extremely bad life property arises. As a result of examining many things about the cause that a life property falls extremely, since the insulation of the insulator layer of the side face of the stripe of a ridge configuration was imperfect, leakage current arose and this invention person surmised that it was for a short circuit to occur. To both attain improvement in the yield as if for ** which suited commercializing a laser component to make component properties, such as a life property, good is desired.
[0004] Then, the object of this invention is offering the nitride semiconductor laser component which can make the insulation of a component good, can prevent prevention and a short circuit of leakage current, and can obtain a component with a good life property with the sufficient yield.

[Translation done.]

MEANS

[Means for Solving the Problem] That is, the configuration of following the (1) - (3) can attain the object of this invention.
(1) It has the component structure of making n mold nitride semi-conductor layer, a barrier layer, and p mold nitride semi-conductor layer coming to grow up at least on a substrate. In the nitride semiconductor laser component which etching comes to form the stripe of a ridge configuration from p mold nitride semi-conductor layer side, and comes to form an insulator layer in the side face of the stripe of said ridge configuration further at least The nitride semiconductor laser component characterized by having the rich layer which contains aluminum or boron at abundance near the front face of the flat surface which is in contact with said insulator layer, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least.
(2) A nitride semiconductor laser component given in the above (1) characterized by coming to form said rich layer in the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least by diffusing aluminum or boron after forming the stripe of a ridge configuration.
(3) A nitride semiconductor laser component given in the above (1) characterized by said rich layer carrying out the ion implantation of aluminum or the boron to the front face of the flat surface which is exposed, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least, and coming to form it in it after forming the stripe of a ridge configuration.
[0006] That is, by forming the rich layer which make abundance come to contain aluminum or boron toward the interior near [, such as a side face of the stripe of a ridge configuration ,] a front face from a front face , this invention act in multiplication with the insulator layer form in the side face of the stripe of a ridge configuration , and the good insulation of it be attain , and it can offer the nitride semiconductor laser component which become possible [preventing leakage current and a short circuit good] . Furthermore, this invention can also attain improvement in the yield by considering as the laser component which has a rich layer.
[0007] Conventionally, as shown in drawing 6 , the insulating insulator layer is formed in the side face of the stripe of a ridge configuration. However, the case where this insulator layer is not uniform good film will arise, insulation will become

imperfect, and a short circuit etc. will occur.
[0008] On the other hand, the result examined variously that this invention person should make the insulation of the part which touches a pad electrode a much more perfect thing, Make aluminum (aluminum) or boron (B) contain near the front face of the flat surface which is continuing from the side face of a stripe, and the side face of a stripe in abundance, and a rich layer is formed. By making into insulation the front face of the component structure exposed by forming the stripe of a ridge configuration itself, a rich layer and an insulator layer can act in multiplication, and can have good insulation.
[0009] furthermore, the thing make for front faces, such as a side face of the stripe of a ridge configuration expose, to diffuse aluminum or boron after a rich layer forming the stripe of a ridge configuration in this invention -- or when it come to be form by carrying out the ion implantation of aluminum or the boron, while being able to form a rich layer good and showing better insulation, it be desirable in respect of improvement in the yield.
[0010] Moreover, in this invention, when an ion implantation is carried out, the refractive index of the part is desirable in aluminum or B, also at diffusion or the point which becomes small and light shuts up. From this, although the laser component of drawing 6 is an effctive-index waveguide mold since p electrode has not touched all over the front face of p mold contact layer, for example An ion implantation is spread or carried out. aluminum or B to the side face of a barrier layer 9 for the laser component of drawing 6 , as shown in drawing 1 By forming the rich layer 201, it becomes a perfect refractive-index waveguide mold because slight optical closing depth becomes good, and the level transverse mode can be stable, lifting of a threshold can be prevented, a life property can be raised, and it is desirable.
[0011]
[Embodiment of the Invention] Drawing 1 - drawing 4 are used for below, and this invention is further explained to it at a detail. Drawing 1 is the typical sectional view showing the part cut at right angles to the die-length direction of the stripe of the ridge configuration of the nitride semiconductor laser component which is the gestalt of the 1 operation which comes to form the rich layer 201 of this invention in the laser component of drawing 6 shown with said conventional technique. Drawing 2 - drawing 4 are the typical sectional views of the nitride semiconductor laser component which is the gestalt of the 1 operation which comes to form the rich layer 201 of this invention in the laser component used as a perfect refractive-index waveguide mold.
[0012] The nitride semiconductor laser component of this invention has the rich layer which contains aluminum or boron at abundance near the front face of the flat surface which is in contact with the insulator layer, and which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe at least in the nitride semiconductor laser component which comes to form an insulator layer in the side face of the stripe of a ridge configuration. Therefore, especially as a laser component which forms a rich layer, it is not limited but, specifically, the laser component of drawing 1 - drawing 4 is mentioned that what is necessary is just the laser component which has the stripe of a ridge

configuration.
[0013] First, the rich layer 201 is explained using drawing 1 . An insulator layer is formed in the side face of the stripe of a ridge configuration at drawing 1 , the p electrode 20 is formed in the maximum upper layer of a stripe, and p pad electrode is formed in the upper part part of a stripe so that p electrode and an electric target may be contacted. And the rich layer 201 is formed near the front face of the flat surface which is continuing from the side face of the stripe of a ridge configuration in which the insulator layer 62 is in contact with component structure, and the side face of a stripe. after protect formation of the rich layer 201 in the case of this drawing 1 so that the rich layer 201 may not be form in the maximum top face (front face of p mold contact layer) of p mold nitride semi-conductor layer , after form the stripe of a ridge configuration , it be make to contain near the front face which be have aluminum or B expose by diffusion and the ion implantation in abundance in the process of formation of the conventional component .
[0014] In this invention, near a front face shows the part which has the depth toward the inside from the front face of the exposed component structure, after forming the stripe of a ridge configuration. For example, the part in which the rich layer 201 shown in drawing 1 -4 is formed is shown. Moreover, in this invention, though it is the same layer as containing in abundance like p mold contact layer of drawing 2 , and p mold cladding layer, more aluminum or B than other parts are contained, and the condition that aluminum and B are unevenly distributed is shown. And the part in which aluminum and B are unevenly distributed is used as the rich layer 201 by this invention.
[0015] In this invention, after formation of the rich layer 201 forms the stripe of a ridge configuration, it is formed in the exposed part by making aluminum or B contain near the front face of the part where especially p pad electrode is formed in an upper part part at abundance. Especially as an approach of making abundance containing aluminum and B, although not limited, after making a part to form a rich layer in vapor-deposit aluminum and B, in this invention, the method of applying and diffusing heat or the approach by the ion implantation is mentioned, for example as a desirable example.
[0016] In this invention, it heat-treats by making the part to diffuse vapor-deposit aluminum or B as an approach of diffusing. As temperature in the case of heat treatment, it is adjusted suitably, for example, is 400 degrees C - 700 degrees C. As time amount of heat treatment, it is adjusted suitably, for example, is 10 minutes - 2 hours. Moreover, when forming the rich layer 201 by diffusion, adjustment of concentration and accommodation of the depth from a front face are performed by adjusting the temperature and time amount of heat treatment.
[0017] aluminum or B which the mask of the part to make it pouring in was carried out [B], and made it ionize all over a wafer by Si oxide film or the resist as an approach of carrying out an ion implantation in this invention -- 10- it is carried out by accelerating to the energy of hundreds keV(s) and devoting oneself to a front face. Moreover, when forming the rich layer 201 by the ion implantation, adjustment of concentration and accommodation of the depth from a front face are performed by adjusting impregnation time amount in acceleration voltage.

[0018] Moreover, it is extent which is limited and can take **** and insulation especially as aluminum of the rich layer 201, or concentration of B, for example, they are specifically three or more 1x1014 atom/cm. Moreover, although especially the thickness (depth from a front face) of the rich layer 201 is not limited, it is extent which can take insulation, for example, is specifically 100A - 2 micrometers.

[0019] for example, as a gestalt of 1 implementation of formation of the ridge layer 201 On a substrate as indicated by J.J.A.P. shown with said conventional technique n mold contact layer, From p mold nitride semi-conductor layer side after forming the component structure of making a barrier layer, p mold contact layer, etc. coming to grow up, by etching etc. After forming the stripe of a ridge configuration, Where a rich layer is made not to be formed in the front face of the maximum upper layer of the stripe of a ridge configuration, (in for example, the condition that protective coats, such as a resist formed on the occasion of etching, are formed) The ridge layer 201 is formed at least by the diffusion and the ion implantation which are exposed and which were shown in the side face of the stripe of a ridge configuration etc. above. Then, an insulator layer 15, the p electrode 20, and p pad electrode 101 grade are formed like said J.J.A.P. etc. And it becomes the laser component which has the rich layer 201 shown in drawing 1 . Especially as an insulator layer 62 of drawing 1 , although not limited, SiO2 grade can be used. Moreover, especially as a stripe of the ridge configuration of drawing 1 , although not limited, the content indicated by J.J.A.P. shown above, for example and the same content are mentioned.
[0020] By forming the rich layer 201, the rich layer 201 and an insulator layer 15 act in multiplication, insulation becomes good, and the laser component shown in drawing 1 can perform prevention of leakage current, and prevention of a short circuit, and turns into a laser component with a good life property. In case the laser component furthermore shown in drawing 1 can be produced with the sufficient yield and mass-produced, it is desirable. Since insulation becomes good [the laser component of this invention], furthermore, the desirable laser component shown in drawing 1 again also in respect of the improvement in the dependability of a component (defect prevention) Although nonuniformity arises in current density inside the stripe of a ridge configuration, the level transverse mode becomes unstable and lifting of a threshold may be seen in the condition of not forming the rich layer 201 since p electrode has not touched all over the front face of p mold contact layer A component property like the laser component of a perfect refractive-index waveguide mold becomes easy to be shown by the refractive index of the part becoming small by making aluminum or B contain, and slight optical closing depth becoming good. Thus, if lifting of a threshold is suppressed, a life property can be made more into fitness. The rich layer 201 shown in drawing 1 can adjust thickness by adjusting suitably according to the diffusion at the time of forming the rich layer 201, or the conditions of an ion implantation, although horizontal thickness differs from vertical thickness to a substrate. The thickness of a rich layer shows whether aluminum or B has entered to the depth of how much in component structure here.
[0021] Next, the laser component of drawing 2 - drawing 4 is explained. By the

whole surface surface of p mold contact layer having touched p electrode, since stripe width of face is narrow, the level transverse mode stabilizes drawing 2 - drawing 4 , since they can suppress lifting of a threshold, they are desirable, and they serve as still more desirable structure as a laser component of a perfect refractive-index waveguide mold. Laminating growth of n mold contact layer 5 - the p mold contact layer 13 is carried out on a substrate at drawing 2 - drawing 5 . The stripe of a ridge configuration is formed by etching from this p mold contact layer side. As the 2nd protective coat 62 (insulating film equivalent to the insulator layer of this invention) is formed in the side face of the stripe of a ridge configuration and p mold contact layer which is the maximum upper layer of a stripe is touched, they are p electrode and the laser component which p pad electrode is formed and becomes so that p electrode may be touched further. Here, although the 2nd protective coat 62 is formed in order to be the insulating film, to be equivalent to the insulator layer of this invention and to maintain the insulation of a component like the insulator layer 15 of drawing 1 , it is faced explaining the phase of formation of drawing 2 - drawing 5 , and let it be the 2nd protective coat 62. And the rich layer 201 of this invention is formed in the flat surface which is continuing from the side face of the stripe of a ridge configuration, and the side face of a stripe as shown in each drawing at such drawing 2 - drawing 5 . By forming the rich layer 201, insulation is shown, it acts in multiplication with the 2nd insulating protective coat 62 currently formed in the side face of a stripe, and the part of the rich layer 201 also makes the insulation of a component good. Prevention of leakage current and prevention of a short circuit become good, and the improvement in a life property and improvement in the yield can be attained because insulation becomes good.

[0022] Especially as the 2nd protective coat 62 used as the insulator layer used for drawing 2 - drawing 5 , although not limited, the oxide which contains at least a kind of element chosen from the group which consists of Ti, V, Zr, Nb, Hf, and Ta, BN, SiC, AlN, etc. are mentioned, for example. Moreover, Si oxide can also be used as the 2nd protective coat 62, and it is carried out by choosing the ingredient which is easy to be etched from Si oxide as an ingredient of the 1st protective coat 61 in this case as mentioned later as mentioned later.

[0023] Especially as stripe geometry of drawing 2 - drawing 5 , although not limited, as desirable stripe geometry, the stripe geometry whose stripe width of face is 0.5-4.0 micrometers, for example can be raised. Stripe width of face is desirable in respect of the lowering of a threshold and the stabilization of the level transverse mode by it being the above-mentioned range. Moreover, as stripe width of face described above as a laser component which has the stripe of structure narrow as mentioned above, the laser component of structure as shown in drawing 2 - drawing 4 is mentioned. Even if these laser components narrow stripe width of face, they are obtained by the stripe and the electrode formation approach (specifically indicated by JP,2000-4063,A.) of forming with sufficient repeatability. Drawing 5 is used and explained about the approach below. By choosing an ingredient so that the etch rates by etching processing with the 1st protective coat 61 used in case the waveguide of a stripe is formed, and the 2nd insulating protective coat 62 formed in the side face of a stripe may differ, and performing

following each process, this approach can form a stripe with sufficient repeatability, and can form the 2nd insulating protective coat 62 in a position by the thickness of homogeneity further.
[0024] Drawing 5 is the typical sectional view showing the partial structure of the nitride semiconductor wafer in each process for explaining each process of the stripe of the nitride semiconductor laser component of drawing 2 - drawing 4 , and the formation approach of an electrode. The sectional view shown in this drawing 5 shows drawing at the time of it being parallel and cutting to a perpendicular direction, i.e., a resonance side, to the stripe waveguide formed by etching.
[0025] First, in the 1st process, as shown in drawing 5 (c), the stripe-like 1st protective coat 61 is formed on p mold contact layer 13 in the maximum upper layer. In this 1st process, as long as the 1st protective coat 61 is an ingredient which does not ask especially insulation but has the etch rate and difference of a nitride semi-conductor, what kind of ingredient is sufficient as it. As the 1st protective coat 61, although choosing and using the ingredient with which the 2nd protective coat 62 formed at the 3rd below-mentioned process differs from an etch rate forms the 2nd protective coat 62, it is still more desirable. As the 1st protective coat 61, for example, Si oxide (SiO_2 is included), a photoresist, etc. are mentioned, and it is Si oxide preferably. Although wet etching, dry etching, etc. are used as an approach it will form the waveguide field of the shape of a stripe of the nitride semiconductor laser component in the 2nd following process if the 1st protective coat 61 is Si oxide, the dry etching which etching tends to carry out is used preferably, and can make good selectivity of the 1st protective coat 61 and nitride semi-conductor to which importance is attached by this dry etching. Moreover, it is easy to dissolve to fluoric acid and is desirable when fluoric acid is used as an acid which has the property which is easy to dissolve rather than the 2nd protective coat by etching which will be performed using an acid at the 3rd process which is an after process if the 1st protective coat 61 is chosen from the above-mentioned ingredient to an acid, is easy to establish a solubility difference with the 2nd protective coat 62, and is used especially at the 3rd process. As stripe width of face (W) of the 1st protective coat, 4 micrometers - 0.5 micrometers are preferably adjusted to 3 micrometers - 1 micrometer. The stripe width of face of the 1st protective coat 61 is about equivalent to the stripe width of face of a waveguide field.
[0026] In the 1st process, the process shown in drawing 5 (a) and (b) is mentioned as a concrete process which forms the 1st protective coat 61. First, as shown in drawing 5 (a), after [the front face of p mold contact layer 13] forming in the whole surface mostly, the stripe-like 3rd protective coat 63 is formed for the 1st protective coat 61 on the 1st protective coat 61. Then, as shown in drawing 5 (b), after etching the 1st protective coat 61, with the 3rd protective coat 63 attached, the 1st protective coat 61 of the shape of a stripe as shown in drawing 5 (c) can be formed by removing the 3rd protective coat 63. In addition, etching gas or an etching means can be changed with the 3rd protective coat 63 attached, and it can also etch from p mold contact layer 13 side.
[0027] In the 1st process, in order to be able to use dry etching like RIE (reactive ion etching), for example and to etch the 1st protective coat 61 which consists of

Si oxide at the 1st process in this case as an etching means, it is desirable to use the gas of a fluorine compound system like CF4.
[0028] Moreover, the 1st protective coat 61 of the shape of a stripe as shown in drawing 5 (c) can also be formed by the lift-off method. By the lift-off method, by forming the photoresist of the configuration which the stripe-like hole opened on p mold contact layer 13, forming the 1st protective coat 61 the whole surface from the photoresist, and carrying out dissolution clearance of the photoresist after that, as shown in drawing 5 (c), it leaves only the 1st protective coat 61 in contact with p mold contact layer 13. In addition, as an approach of forming the 1st protective coat 61, it is in the inclination for the stripe with which an end face is [to form by etching, as shown in drawing 5 (a) and (b)] almost more nearly vertical, and the configuration was ready to be easy to be obtained rather than it forms the stripe-like 1st protective coat 61 by the lift-off method.
[0029] Next, in the 2nd process, as shown in drawing 5 (d), it etches from the part in which the 1st protective coat 61 of p mold contact layer 13 in which the 1st protective coat 61 was formed is not formed, and the waveguide field of the shape of a stripe according to the configuration of a protective coat is formed in a part for the direct lower part of the 1st protective coat 61. When etching, the structure of a laser component differs from a property by into which location a dirty stop is made. As long as a dirty stop is a layer below p mold contact layer, it may be stopped in any nitride semi-conductor layer. In the example shown in drawing 5 , the middle of p mold cladding layer 12 under p mold contact layer 13 is considered as the dirty stop. If a substrate side is a dirty stop from the soffit side of p mold cladding layer rather than the 0.2 micrometers of the directions of p mold contact layer, a stripe will serve as a ridge and the laser component of a refractive-index waveguide mold will be made. A soffit side points out the field of the bottom cladding layer to the thickness direction, and as stated also in advance, when a lightguide layer is under a cladding layer, the interface of a guide layer and a cladding layer is equivalent to a soffit side. If a dirty stop is carried out above this soffit side, since etching time will become short and it will be easy to control an etching rate, convenience on industrial engineering is good.
[0030] Moreover, a dirty stop can also be used as the nitride semi-conductor below the soffit side of p mold cladding layer although not shown in drawing 5 . When the layer by the side of a substrate is a dirty stop, it is [an inclination for a threshold to fall remarkably] and is more desirable than a soffit side.
[0031] In the 2nd process, as an etching means, although wet etching, dry etching, etc. are used, the dry etching which etching tends to carry out is used preferably. For example, if dry etching like RIE (reactive ion etching) can be used, the gas of a chlorine system like Cl2, CCl4, and SiCl4 used well at other groups III-V semiconducter to etch a nitride semi-conductor in this case is used and these gas is used, when Si oxide is used as the 1st protective coat 61, since a selection ratio with Si oxide is made greatly, it is desirable.
[0032] After etching as shown in (d) of drawing 5 , and forming the stripe of a ridge configuration, the rich layer 201 is formed. The approach of formation of the rich layer 201 is as having described above. The condition of having formed vacuum evaporationo film, such as aluminum, in the flat surface which is continuing from

the side face of the stripe of a ridge configuration and its side face by vacuum evaporationo is shown in drawing 5 (e-1). Abundant parts, such as aluminum, are formed toward the interior after forming vacuum evaporationo film, such as this aluminum, from the front face of the component structure which is in contact with vacuum evaporationo film, such as aluminum, with thermal diffusion. Then, the rich layer 201 can be formed by removing vacuum evaporationo film, such as aluminum, as shown in drawing 5 (e-2).

[0033] Next, in the 3rd process, after forming the rich layer 201, as shown in drawing 5 (f), it is an ingredient which is different from the 1st protective coat 61 in the 2nd protective coat 62, and forms using the ingredient which has insulation on the side face of stripe-like waveguide, the flat surface of the nitride semi-conductor layer (drawing 5 (f) p mold cladding layer 12) which it was etched and was exposed, and the 1st protective coat 61. After forming the 2nd protective coat 62, by removing the 1st protective coat 61 by etching, only the 2nd protective coat 62 formed on the 1st protective coat 61 is removed, and as shown in drawing 5 (g), the 2nd protective coat 62 is continuously formed in the side face of a stripe, and the flat surface of p mold cladding layer 12. Thus, in order to make it possible to remove the 1st protective coat 61, without etching the 2nd protective coat 62, as described above, it becomes possible by choosing and using that from which the etch rate to the etching processing performed at the 3rd process differs the ingredient of the 1st protective coat 61 and the 2nd protective coat 62. Although especially etching processing at the 3rd process is not limited, the approach of carrying out dry etching, for example using fluoric acid is mentioned.

[0034] It is chosen from a different ingredient from the 1st protective coat 61 as an ingredient of the 2nd protective coat 62, and it will not be limited, especially if it is the ingredient which is hard to be etched by etching processing of the 3rd process or an etch rate is slower than the 1st protective coat 61 and is the ingredient which can form the 2nd protective coat 62 in the side face of a stripe etc. As the 2nd desirable protective coat, from Si oxide and a resist ingredient being preferably used as the 1st protective coat 61 as mentioned above, it is ingredients other than the ingredient of the 1st protective coat 61 at least, and an ingredient with an etch rate slower than the 1st protective coat 61 is mentioned. When the 1st protective coat 61 is Si oxide, a kind is used for inside [it is the oxide which contains at least a kind of element chosen from the group which consists of Ti V, Zr, Nb, Hf, and Ta, for example as an example of the 2nd protective coat 62, and BN, SiC and AlN] at least, and the oxide of Zr, the oxide of Hf, and any one or more sorts of ingredients of BN and SiC are used more preferably. Moreover, after the 2nd protective coat 62 formation, in order not to etch a nitride semi-conductor, the 2nd protective coat 62 is not taken into consideration about etching speed with a nitride semi-conductor. Moreover, as 2nd thin film layer 62, Si oxide may be used and the 1st protective coat 61 is performed in this case by choosing an ingredient with the etch rate quicker than Si oxide in the 3rd process.

[0035] Moreover, like the above, by continuing and forming the 2nd protective coat on the 1st protective coat 61, high insulation can be held, and since it can form by uniform thickness on p mold cladding layer 12, generating of concentration of the

current resulting from the ununiformity of thickness can be prevented. Moreover, in the 2nd process of the above, since the dirty stop is considered as the middle of p mold cladding layer 12, as the 3rd process shows to drawing 5 (f), the 2nd protective coat 62 is formed in the flat surface of p mold cladding layer 12, but if a dirty stop is carried out below p mold cladding layer 12, the 2nd protective coat will be formed in the flat surface of the nitride semi-conductor layer which carried out the dirty stop.
[0036] Moreover, the 2nd protective coat 62 can also be formed by the lift-off method. For example, it is either of the examples which the 2nd protective coat 62 described above, and if the 1st protective coat 61 is used as Si oxide, the 2nd protective coat 62 has the etch selectivity of being hard to be etched or an etch rate is slower than Si oxide, to fluoric acid. For this reason, if only the 1st protective coat 61 is removed by the lift-off method after forming the 2nd protective coat succeeding the side face of stripe waveguide, the flat surface (dirty stop layer) in which that stripe is formed, and the front face of the 1st protective coat 61, as shown in drawing 5 (f), the 2nd protective coat 62 with uniform thickness will be formed to a flat surface as shown in drawing 5 (g).
[0037] Next, in the 4th process, as shown in drawing 5 (h), the p electrode 20 electrically connected with the p mold contact layer 13 is formed on the 2nd protective coat 62 and p mold contact layer 13. Here, since the 2nd protective coat 62 is already formed of said process, in case p electrode is formed, there is no need for fine actuation of forming only in the narrow contact layer of stripe width of face, p electrode can be formed by the large area and operability becomes good.
[0038] moreover, in this invention, when it may have the stripe of the ridge configuration where the above width of face is narrow, as a p pad electrode formed on p electrode The 1st thin film layer which contains the metal which covered whole p electrode surface and was formed by the same die length as stripe die length desirable at least although not limited especially, this -- when it is formed from the 2nd thin film layer containing the metal formed by die length shorter than stripe die length on the 1st thin film layer or comes to form the 3rd thin film layer between the 1st and the 2nd thin film layer, it is desirable, although the cleavability of p pad electrode improves and exfoliation of p electrode is prevented. For example, p pad electrode 101 which comes to form the 2nd thin film layer 32 on the 1st thin film layer 31 shown in drawing 2 used in the below-mentioned example is mentioned.
[0039] The 1st thin film layer is desirable in respect of heat dissipation nature etc. to cleavability, an adhesive property, and a pan in their being more than kinds, such as nickel, Ti, Cr, W, and Pt. Moreover, when the 2nd thin film layer consists of Au, the heat conductivity becomes it is good and good [stripping of heat], and it is still more desirable in respect of the adhesive property in the case of bonding, relaxation of an impact, etc. Although the 2nd thin film layer which consists of Au is inferior in cleavability, since it is a configuration shorter than stripe die length, the end face of the 2nd thin film layer is not in agreement with the cleavage plane formed of cleavage, and does not affect the cleavability of p pad electrode at all. Moreover, when the 3rd thin film layer containing at least one or more sorts of

ingredients, such as Pt, W, TiN, Cr, and nickel, is formed between the 1st thin film layer and the 2nd thin film layer, it can prevent that the 3rd thin film layer turns into a barrier layer, and the metal of the 2nd thin film layer is spread, and is desirable. Thus, when diffusion of the 2nd thin film layer can be prevented, it is desirable for lifting of resistance and lifting of a threshold being suppressed, and generating of the heat inside a laser component being prevented by it, and raising a life property.

[0040] In this invention, the electrode which has the ohmic contact which can choose various ingredients suitably, and can use them as p and an n electrode, for example, is indicated by said J.J.A.P. is mentioned.

[0041] Moreover, in order to be obstructed by n electrode, and for a scribe not to attain even a nitride semi-conductor and to prevent this trouble if SUKURAIBUSU [a substrate rear face / solid one / n electrode] from an after [formation] rear face when n electrode is formed in a substrate rear face, by forming n electrode of a pattern configuration in the substrate rear face of a wafer, it becomes easy to carry out a scribe and cleavability improves. the configuration of one chip obtained by carrying out cleavage of the wafer as a pattern configuration is easy to be acquired -- as -- a configuration almost comparable as a chip size, for example, a 400micrometerx400micrometer configuration, -- it comes out and a certain thing is desirable. That is, a pattern is attached and n electrode is formed so that n electrode may not exist on a scribe line and/or a cleavage plane. Furthermore, if a metallizing electrode is also formed on n electrode in the same pattern configuration as n electrode, it will become easy to carry out the scribe of it, and its cleavability will improve. Especially as an n electrode, although not limited, Ti-aluminum, W-aluminum-W-Au, etc. can be used, for example. As a metallizing electrode, 0.1 micrometer-0.2micrometer[of Ti-Pt-Au-(Au/Sn) [thickness]-0.7micrometer-0.3micrometer], Like the Ti-Pt-Au-(Au/Si) [thickness above, like] and the Ti-Pt-Au-(Au/germanium) [thickness above],] etc. can be used like] and the Au/germanium[thickness above like] and the Au/Si[thickness above like] and the [0.3 micrometers of Au/Sn thickness] In[thickness above like the Ti-Pt-Au-In [thickness above. As the approach of chip-izing in case n electrode is formed in a rear face at a pattern configuration, a bar-like sample can be produced for between n electrode patterns on the back by the scribe from a rear face, and a scribe can perform chip-ization from the rear face after reflective mirror formation to an end face, for example.

[0042] Moreover, especially as component structure of others of the laser component of this invention, it is not limited but well-known various component structures can be used. or [that the nitride semi-conductor of SiO2 grade does not grow on different-species substrates known conventionally, such as sapphire and a spinel, or a different-species substrate as a substrate into which the component structure of the laser component of this invention is grown up] -- or the protective coat which consists of an ingredient which cannot grow easily forms, and the nitride semi-conductor substrate which is made to carry out lateral growth (lateral growth) selectively on it, and is obtained is mentioned. A nitride semi-conductor substrate with few crystal defects which are made to carry out lateral growth preferably and are acquired is desirable. When component structure

is formed on a nitride semi-conductor substrate with few crystal defects, it is desirable,, although the crystal defect of the nitride semi-conductor which constitutes a component decreases and generation of heat within a component is suppressed. Moreover, it becomes easy to carry out cleavage of the substrate to being a nitride semi-conductor substrate, and it is desirable also in respect of peeling prevention of p electrode. The protective coat used when the protective coat used for lateral growth formed said stripe shows a different operation.
[0043] As the growth approach of a nitride semi-conductor substrate with few crystal defects acquired using lateral growth Although it may not be limited but which approach may be used, especially, for example An approach given in J.J.A.P.Vol.37(1998) pp.L309-L312, The concavo-convex section is formed in the nitride semi-conductor front face which these people grew up on a different different-species substrate from the nitride semi-conductor currently indicated by JP,11-191659,A which applied previously. After forming said protective coat of SiO2 grade on the flat surface of the heights and a crevice, the method of connecting the nitride semi-conductor which grew the longitudinal direction and grew up to be the protective coat upper part in the longitudinal direction mutually from the nitride semi-conductor exposed to the side face etc. is mentioned. Moreover, in case the nitride semi-conductor substrate obtained with lateral growth grows up component structure, even if it performs it in the condition of having a different-species substrate, where a different-species substrate is removed, it may be performed.
[0044] The resonance side of the laser component of this invention can form a good mirror plane-like resonance side by carrying out cleavage in respect of {11-00} of a nitride semi-conductor [the field equivalent to the side face of a Mth page:hexagonal prism-like crystal] so that it may become vertical to the stripe of a ridge configuration. The detail is indicated about the cleavage in the Mth page of a nitride semi-conductor by JP,9-232676,A for which these people applied previously, for example.

[Translation done.]

EXAMPLE

[Example] The example of the nitride semiconductor laser component which is the gestalt of 1 operation of the following this inventions is shown. However, this invention is not limited to this.
[Example 1] drawing 2 is the typical sectional view showing the structure of the laser component concerning one example of this invention, and shows drawing at the time of cutting in a direction vertical to stripe waveguide. Hereafter, an example 1 is explained based on this drawing.
[0046] (Substrate layer 2) The different-species substrate 1 which consists of sapphire which makes 1inchphi and C side a principal plane is set in a MOVPE reaction container, temperature is made into 500 degrees C, and the buffer layer which consists of GaN is grown up by 200A thickness using trimethylgallium (TMG) and ammonia (NH3). Temperature is made into 1050 degrees C after buffer layer growth, and the substrate layer 2 which similarly consists of GaN is grown up by 4-micrometer thickness. This substrate layer forms a protective coat in a front face selectively, and acts as a substrate layer for next performing selective growth of a nitride semi-conductor substrate.
[0047] (Protective coat 3) The protective coat 3 which forms a stripe-like photo mask in the front face of ejection and this substrate layer from a reaction container, and consists a wafer of SiO2 with a stripe width of face [of 10 micrometers] and a stripe spacing (window part) of 2 micrometers with PVD equipment is formed after substrate layer growth.
[0048] (Nitride semi-conductor substrate 4) A wafer is again set in the reaction container of MOVPE after protective coat formation, temperature is made into 1050 degrees C, and the nitride semi-conductor substrate 4 which consists of undoping GaN is grown up by 20-micrometer thickness using TMG and ammonia. The double or more figures crystal defect of this nitride semi-conductor substrate decreases as compared with 2 or less [105 //cm] and substrate layers 2 in order to grow up to be a longitudinal direction in the protective coat 3 upper part.
[0049] (n mold contact layer 5) Next, n mold contact layer 5 which consists of GaN which doped Si 3x1018-/cm3 at 1050 degrees C on the nitride semi-conductor substrate 1 is grown up by 4-micrometer thickness, using silane gas as ammonia, TMG, and impurity gas.
[0050] (Crack prevention layer 6) Next, the crack prevention layer 6 which makes temperature 800 degrees C and consists of In0.06Ga0.94N is grown up by 0.15-

micrometer thickness using TMG, TMI (trimethylindium), and ammonia. In addition, this crack prevention layer is omissible.
[0051] (n mold cladding layer 7) Then, the layer which consists of undoping aluminum0.16Ga0.84N using TMA (trimethylaluminum), TMG, and ammonia at 1050 degrees C is grown up by 25A thickness, TMA is stopped continuously and the layer which consists of an n mold GaN which doped a sink and Si for silane gas 1x1019-/cm3 is grown up by 25A thickness. Crosswise lamination of those layers is carried out, a superlattice layer is constituted, and n mold cladding layer 7 which consists of superlattice of the 1.2 micrometers of the total thickness is grown up.
[0052] (n mold lightguide layer 8) Then, n mold lightguide layer 8 which consists silane gas of undoping GaN at a stop and 1050 degrees C is grown up by 0.1-micrometer thickness. n mold impurity may be doped in this n mold lightguide layer 8.
[0053] (Barrier layer 9) Next, temperature is made into 800 degrees C, the barrier layer which consists of Si dope In0.05Ga0.95N is grown up by 100A thickness, and the well layer which consists of undoping In0.2Ga0.8N at the same temperature continuously is grown up by 40A thickness. The laminating of a barrier layer and the well layer is carried out twice alternately, finally it is finished as a barrier layer, and the barrier layer of the multiplex quantum well structure (MQW) of the 380A of the total thickness is grown up.
[0054] (p mold cap layer 10) Next, raising, TMG and TMA, ammonia, and Cp2Mg (magnesium cyclopentadienyl) are used for 1050 degrees C for temperature, and p mold cap layer 7 which consists of p mold aluminum0.3Ga0.7N with larger bandgap energy which doped Mg 1x1020-/cm3 than p mold lightguide layer 11 is grown up by 300A thickness.
[0055] (p mold lightguide layer 11) continuing -- Cp2 -- p mold lightguide layer 11 which bandgap energy becomes from the undoping GaN smaller than p mold cap layer 10 at a stop and 1050 degrees C about Mg and TMA is grown up by 0.1-micrometer thickness.
[0056] (p mold cladding layer 12) then, the layer which consists of undoping aluminum0.16Ga0.84N at 1050 degrees C is grown up by 25A thickness -- making -- continuing -- Cp2 -- the layer which consists Mg and TMA of a stop and undoping GaN is grown up by 25A thickness, and p mold cladding layer 12 which consists of a superlattice layer of the 0.6 micrometers of the total thickness is grown up.
[0057] (p mold contact layer 13) p mold contact layer 13 which finally consists of a p mold GaN which doped Mg 1x1020-/cm3 on p mold cladding layer 9 at 1050 degrees C is grown up by 150A thickness.
[0058] The protective coat which becomes the front face of p mold contact layer of the ejection from a reaction container and the maximum upper layer from SiO2 about the wafer into which the nitride semi-conductor was grown up as mentioned above is formed, and it etches by SiCl4 gas using RIE (reactive ion etching), and as shown in drawing 2 , the front face of n mold contact layer 5 which should form n electrode is exposed. Thus, for etching a nitride semi-conductor deeply, it considers as a protective coat, and SiO2 is the optimal.
[0059] Next, mostly, as shown in drawing 5 (a), after forming the 1st protective

coat 61 of p·mold contact layer 13 of the maximum upper layer which consists of an Si oxide (mainly SiO2) by 0.5-micrometer thickness with PVD equipment, the mask of a predetermined configuration is covered on the 1st protective coat 61, and the 3rd protective coat 63 which consists of a photoresist is formed in the whole surface by 1 micrometer in stripe width of face of 2 micrometers, and thickness.
[0060] Next, as shown in drawing 5 (b), said 1st protective coat 61 is etched by using the 3rd protective coat 63 as a mask using CF4 gas after the 3rd protective coat 63 formation and with RIE (reactive ion etching) equipment, and it considers as the shape of a stripe. By processing with an etching reagent after that and removing only a photoresist, as shown in drawing 5 (c), the 1st protective coat 61 with a stripe width of face of 2 micrometers can be formed on p mold contact layer 13.
[0061] Furthermore, as shown in drawing 5 (d), after the 1st protective coat 61 formation of the shape of a stripe, p mold contact layer 13 and p mold cladding layer 12 are again etched using SiCl4 gas by RIE, and a stripe-like waveguide field (ridge stripe in this case) is formed. The transverse mode is [that it is easy to become a single mode] dramatically desirable when it is the configuration of an order mesa where the cross-section configuration of the stripe is shown in drawing 2 , in case a stripe is formed.
[0062] Where the film for protecting so that a rich layer may not be formed in p mold contact layer 13, after forming the stripe of a ridge configuration is attached, on the flat surface which is continuing from the side face of the stripe of a ridge configuration, and its side face, aluminum is vapor-deposited with PVD equipment and the vacuum evaporationo film is formed [drawing 5 (e-1)]. Next, in an annealing furnace, it heat-treats by applying predetermined time amount and heat. Then, an acid removes the vacuum evaporationo film of aluminum. Thus, the rich layer 201 is formed like drawing 5 (e-2).
[0063] A wafer is transported to PVD equipment after forming the rich layer 201, and as shown in drawing 5 (f), the 2nd protective coat 62 which consists of a Zr oxide (mainly ZrO2) is continued and formed by 0.5-micrometer thickness on p mold cladding layer 12 exposed by etching the 1st protective coat 61 top.
[0064] Next, as it is immersed in fluoric acid and a wafer is shown in drawing 5 (g), the 1st protective coat 61 is removed by the lift-off method.
[0065] Next, as shown in drawing 5 (h), the p electrode 20 which consists of nickel/Au is formed in the front face of the p mold contact layer which the 1st protective coat 61 on p mold contact layer 13 was removed, and was exposed. However, as stripe width of face of 100 micrometers, the p electrode 20 is gone across and formed on the 2nd protective coat 62, as shown in this drawing 5 (h).
[0066] Next, succeeding the whole surface on the p electrode 20, the 1st thin film layer 31 which consists of Ti is formed by 1000A thickness, and as further shown in drawing 2 , the 1st thin film layer 31 is formed in the side face of a stripe etc. The upper part of the magnitude which is not in agreement with the cleavage plane at the time of forming a resonance side by cleavage at a next process on this 1st thin film layer 31 formed continuously, i.e., the part used as a cleavage plane, is avoided, the 2nd thin film layer 32 which consists of Au intermittently is formed by

8000A thickness, and p pad electrode 101 which consists of the 1st thin film layer 31 and the 2nd thin film layer 32 is formed.
[0067] The n electrode 21 which consists of Ti/aluminum is formed in the front face of n mold contact layer 5 exposed at the very first in a direction parallel to a stripe after p pad electrode formation, and n pad electrode which consists of Ti/Pt/Au is formed on it.
[0068] After grinding the silicon on sapphire of the wafer which formed n electrode, p electrode, and p pad electrode as mentioned above and being referred to as 70 micrometers, in a direction vertical to a stripe-like electrode, cleavage is carried out to the shape of a bar from a substrate side, and a resonator is produced to a cleavage plane (11 the 00th [-] page, a hexagon head field = equivalent to the side face of a pillar-shaped crystal Mth page). The dielectric multilayer which consists of SiO2 and TiO2 is formed in a resonator side, and, finally it considers as a laser component as cut a bar and shown in drawing 2 in a direction parallel to p electrode. In addition, as for cavity length, it is desirable to be referred to as 300-500 micrometers.
[0069] When this laser component is installed in a heat sink, wire bonding of each electrode is carried out and laser oscillation is tried at a room temperature, in the oscillation wavelength of 400-420nm, and threshold-current consistency 2.9 kA/cm2, a room temperature shows a good continuous oscillation. Furthermore, leakage current and a short circuit can be prevented, a laser component with a good life property can be obtained efficiently, and the yield improves because insulation became good.
[0070] In the [example 2] example 1, the rich layer 201 which consists of aluminum is formed by the ion implantation, and also a laser component is produced similarly. As the approach of an ion implantation, it is in the condition which attached the protective coat to the maximum top face of p mold contact layer 13, and aluminum is accelerated from a wafer top face to predetermined energy with ion implantation equipment, and it is devoted to a wafer. Next, a carrier beam part is heat-treated and a damage is made to recrystallize by the ion implantation. The obtained laser component shows a good component property like an example 1, and its yield also improves further.
[0071] [Example 3] drawing 3 is the typical sectional view showing the structure of the laser component concerning other examples of this invention, and explains an example 3 below based on this drawing.
[0072] (Nitride semi-conductor substrate 40) In an example 1, a wafer is again set to the front face of the substrate layer 2 in the reaction container of MOVPE after stripe-like formation [protective coat 3], temperature is made into 1050 degrees C, and Undoping GaN is grown up by 5-micrometer thickness using TMG and ammonia. Then, a wafer is transported to HVPE (hydride vapor growth) equipment, Ga metal, HCl gas, and ammonia are used for a raw material, and the nitride semi-conductor substrate 40 which consists of undoping GaN is grown up by 200-micrometer thickness. thus, MOVPE -- HVPE after growing up a nitride semi-conductor on a protective coat 3 by law -- if a GaN thick film 100 micrometers or more is grown up by law, even if it compares a crystal defect with an example 1, it will be acquired, and will decrease single or more figures. After nitride semi-

conductor substrate 40 growth, polish removes the ejection from a reaction container, silicon on sapphire 1, a buffer layer 2, a protective coat 3, and an undoping GaN layer, and let a wafer be independent [nitride semi-conductor substrate 40].
[0073] The rest carries out the laminating even of n mold contact layer 5 – the p mold contact layer 13 on the nitride semi-conductor substrate 40 of an opposite hand a polish side like an example 1.
[0074] Like an example 1 after p mold contact layer 13 growth, let an etching stop be the front face of n mold contact layer 5 in the 2nd process after forming the stripe-like 1st protective coat 61. The rest forms an electrode in each contact layer, after forming in the side face of stripe waveguide, and the front face of n mold contact layer 5 the 2nd protective coat 62 which uses ZrO2 as a principal component after forming the rich layer 201 which consists of aluminum like an example 1. Next, p pad electrode 101 is formed like an example 1, and it considers as the laser component of structure as shown in drawing 3 . In addition, when forming a resonance side, the cleavage plane of a nitride semi-conductor substrate may be the Mth same page as an example 1. A threshold-current consistency falls [the obtained laser component] even to 1.8 kA/cm2 as compared with an example 1, a life can improve by 3 or more times, leakage current and a short circuit can prevent good by insulating improvement still like an example 1, and the laser component which has a good life property can be produced with the sufficient yield.
[0075] [Example 4] drawing 4 is the typical sectional view showing the structure of the laser component concerning other examples of this invention, and explains an example 4 using this drawing 4 below.
[0076] In an example 3, in case the nitride semi-conductor substrate 40 is produced, in HVPE equipment, silane gas is added to a raw material, and the nitride semi-conductor substrate 50 which consists of GaN which doped Si 1x1018-/cm3 is grown up by 200-micrometer thickness. In addition, as for Si concentration, it is desirable to consider as the range of three to 5x1019/cm3 of 1x1017-/cm. Silicon on sapphire 1, a buffer layer 2, a protective coat 3, and an undoping GaN layer are ground and removed like an example 3 after nitride semi-conductor substrate 50 growth, and it considers as nitride semi-conductor substrate 50 simple substance.
[0077] Next, laminating growth even of the crack prevention layer 6 – the p mold contact layer 13 is carried out like an example 1 on this nitride semi-conductor substrate 50. Like an example 1 after p mold contact layer 13 growth, after forming the stripe-like 1st protective coat 61, in the 2nd process, it considers as the front face of n mold cladding layer 7 which shows an etching stop to drawing 5 . Like an example 1, the rest forms the rich layer 201, and after that, after it forms in the side face of stripe waveguide, and the front face of n mold cladding layer 7 the 2nd protective coat 62 which uses ZrO2 as a principal component, it forms the p electrode 20 through the 2nd protective coat.
[0078] The 1st thin film layer 31 which consists of Ti on the p electrode 21 so that it may become stripe die length and the same die length next, by 1000A of thickness The 3rd thin film layer which consists of Pt in the configuration of the 2nd thin film layer 32, and the same configuration by 1000A of thickness And p pad

electrode 101 which comes to carry out laminating formation of the 2nd thin film layer 32 which consists of Au in a configuration shorter than stripe die length by 8000A of thickness at order is formed as shown in drawing 4 . Although the 3rd thin film layer is not illustrated, it forms in the same configuration as the 2nd thin film layer. on the other hand -- the rear-face side of a nitride semi-conductor substrate -- the n electrode 21 is mostly formed in the whole surface. After electrode formation, cleavage is carried out by the Mth page of a nitride semi-conductor substrate, and a resonance side is produced and it considers as the laser component of structure as shown in drawing 4 .

[0079] [Example 5] As shown in the laser component of drawing 6 which shows the laser component indicated by said J.J.A.P. at drawing 1 , the laser component which comes to form the rich layer 201 like an example 1 is produced. Insulation can become good, and the obtained laser component can prevent generating of leakage current, and generating of a short circuit, and can produce a component with a good life property with the sufficient yield.

[0080] In the [example 6] example 1, the laser component which has it come to form the rich layer 201 which change to aluminum, and B is used, and also contains B in abundance by diffusion similarly is produced. Consequently, a good result almost equivalent to an example 1 is obtained.

[0081] In the [example 7] example 2, the laser component which has it come to form the rich layer 201 which change to aluminum, and B is used, and also contains B in abundance by the ion implantation similarly is produced. Consequently, a good result almost equivalent to an example 1 is obtained.

[Translation done.]

DESCRIPTION OF DRAWINGS

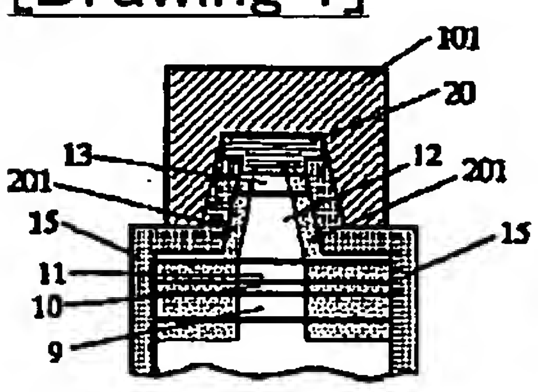
[Brief Description of the Drawings]
[Drawing 1] It is the typical sectional view showing a part of nitride semiconductor laser component concerning the gestalt of 1 operation of this invention.
[Drawing 2] It is the typical sectional view of the nitride semiconductor laser component concerning the gestalt of 1 operation of this invention.
[Drawing 3] It is the typical sectional view of the nitride semiconductor laser component concerning the gestalt of 1 operation of this invention.
[Drawing 4] It is the typical sectional view of the nitride semiconductor laser component concerning the gestalt of 1 operation of this invention.
[Drawing 5] It is the typical sectional view showing the partial structure of the wafer in each process for explaining each process of the approach of forming the stripe of the ridge configuration of drawing 2 - drawing 4 etc.
[Drawing 6] It is the typical sectional view showing the structure of the conventional laser component.
[Description of Notations]
1 ... Different-species substrate
2 ... Substrate layer
3 ... Protective coat for nitride semi-conductor substrate growth
4, 40, 50 ... Nitride semi-conductor substrate
5 ... n mold contact layer
6 ... Crack prevention layer
7 ... n mold cladding layer
8 ... n mold lightguide layer
9 ... Barrier layer
10 ... p mold cap layer
11 ... p mold lightguide layer
12 ... p mold cladding layer
13 ... p mold contact layer
15 ... Insulator layer
61 ... The 1st protective coat
62 ... The 2nd protective coat
63 ... The 3rd protective coat
20 ... p electrode
21 ... n electrode

31 ... 1st thin film layer
32 ... 2nd thin film layer
101 ... Pad electrode
201 ... Rich layer

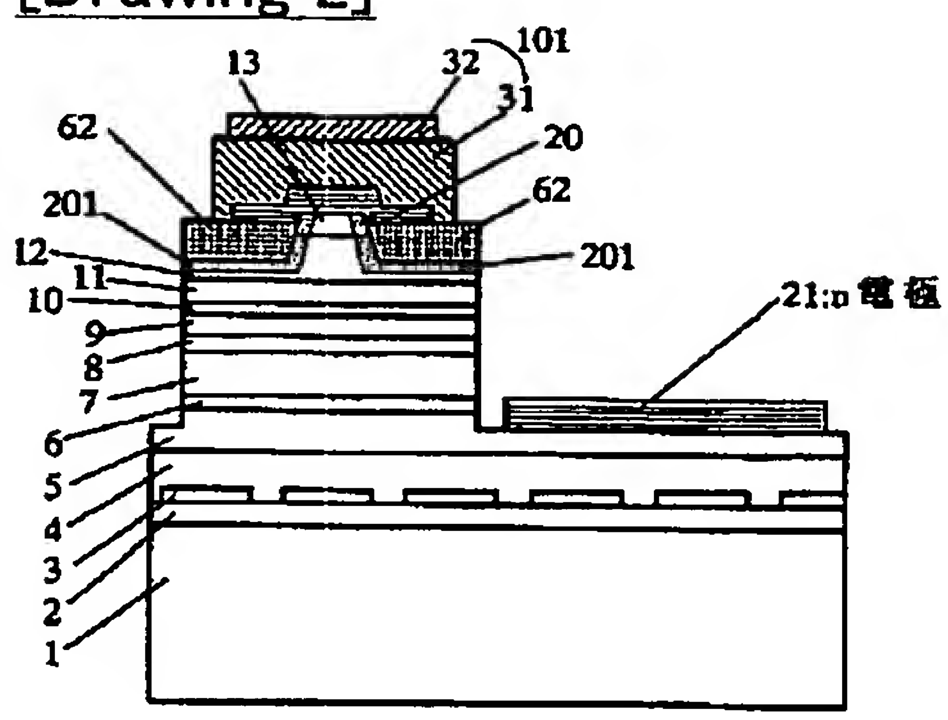
[Translation done.]

DRAWINGS

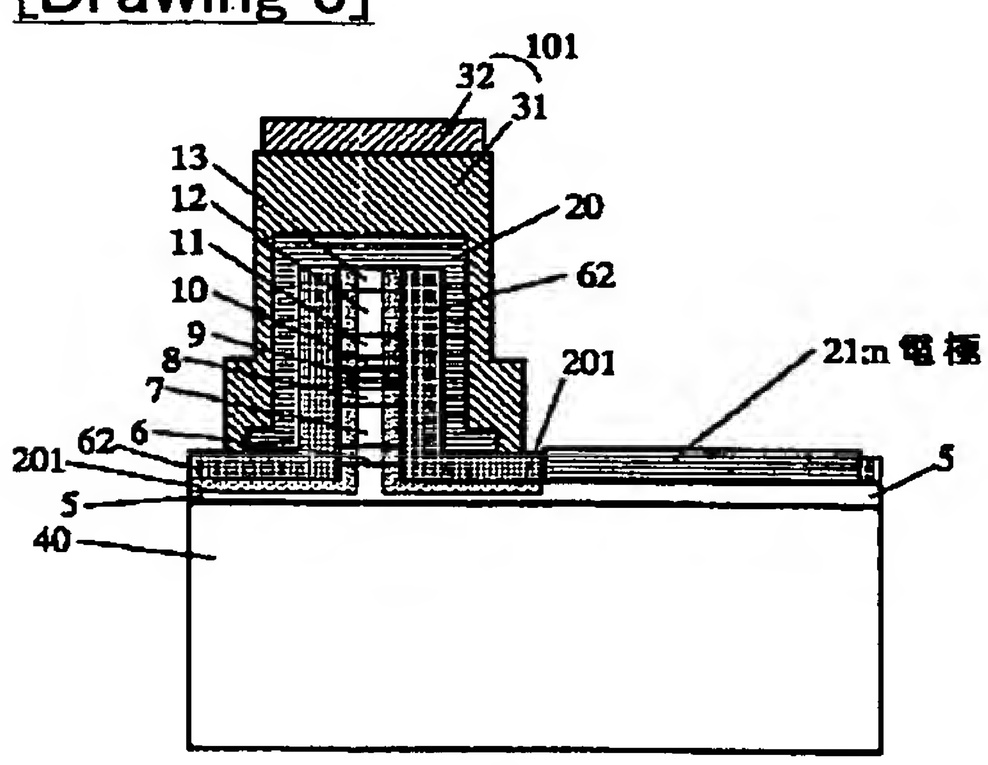
[Drawing 1]



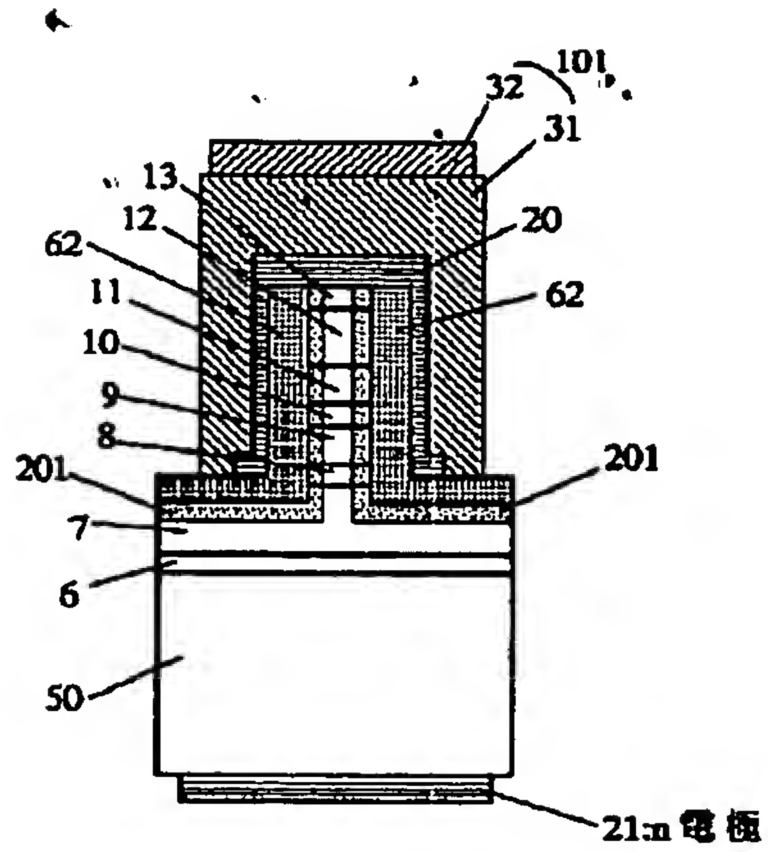
[Drawing 2]



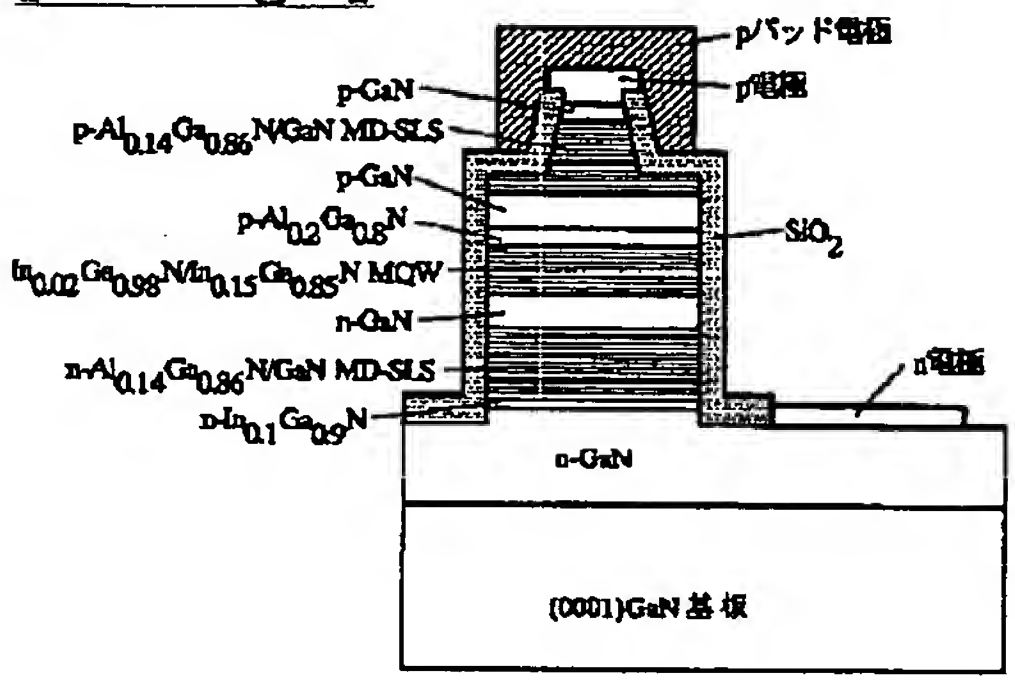
[Drawing 3]



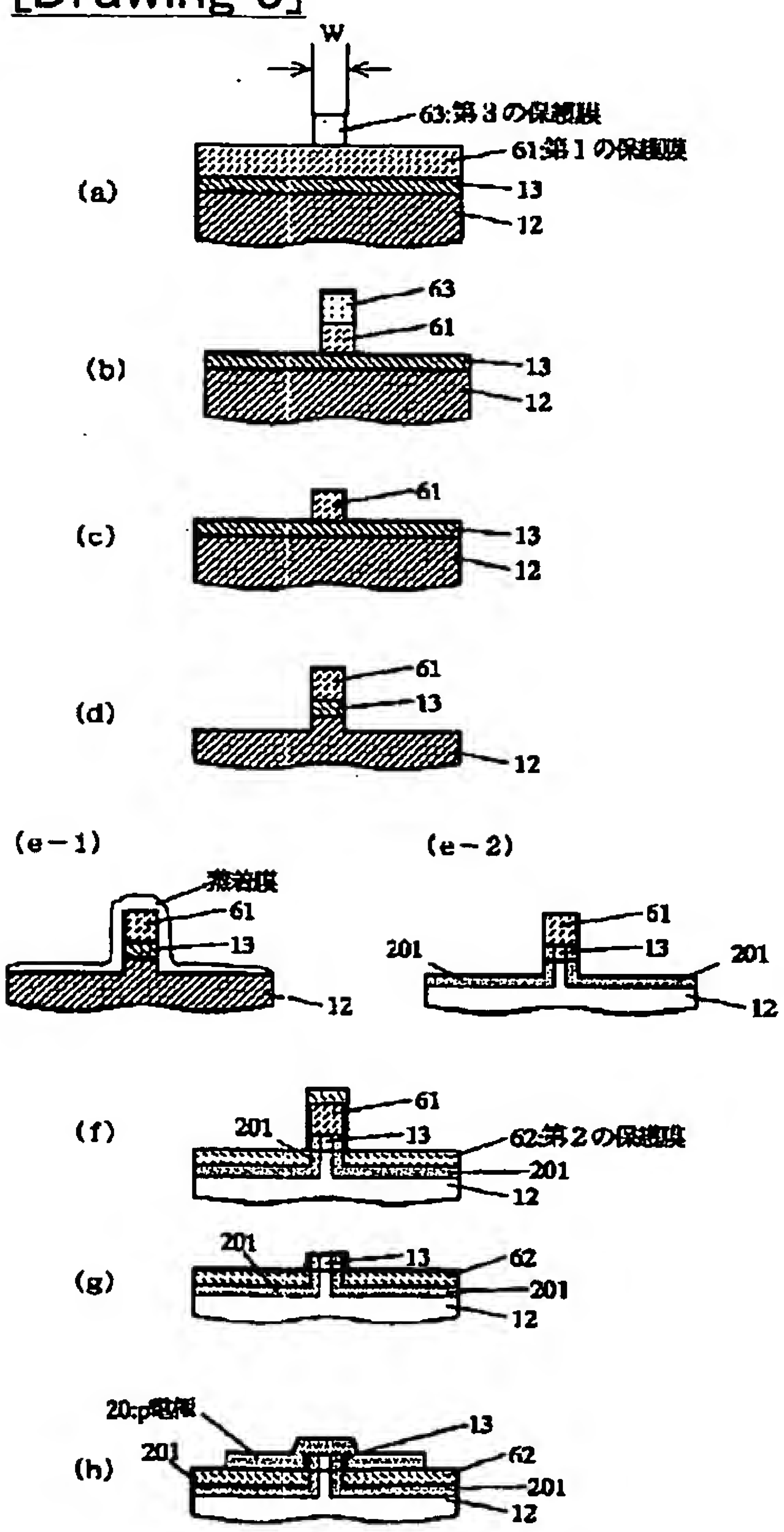
[Drawing 4]



[Drawing 6]



[Drawing 5]



[Translation done.]